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Pot Shrimp Stock Assessment Survey Results from 1996-2003 in Districts 3, 7, 12, and 13 of Southeast Alaska

by

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and

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ABSTRACT

The purpose of this Regional Information Report is to present a summary of the pot shrimp survey data collected from all of the districts surveyed to date in Southeast Alaska in order to facilitate its use in management of this fishery. The format used was developed to provide a consistent, yet complete, summary by district by the most precise common denominators: statistical area, year, survey type and mesh size.

INTRODUCTION

The spot shrimp fishery in Southeast Alaska is currently the only viable commercial pot shrimp fishery in the state. Spot shrimp, *Pandalus platyceros,* comprise the majority of the landed weight; the remainder is primarily coonstripe shrimp, *P. hypsinotus*. A 10-fold increase in participating vessels since 1960 has heightened concern for conservation of shrimp stocks and led to increasing restrictions, including limited entry in 1996. Vessel configuration is a function of market demand but appears to be evolving from smaller vessels with a limited fresh local market to larger catcher-processors, which sell frozen whole shrimp, primarily to the Japanese market. The season has shortened from year-round in 1981 to the current season, which by regulation begins on October 1 and ends February 28. Districts close once target GHLs have been achieved. In the past, the length of the season has ranged from 4 to 338 days depending on the district. Districts in which harvest has not reached the upper end of their associated guideline harvest range may be reopened by emergency order May 1, the following summer. Guideline Harvest Ranges (GHRs) were established for each district in 1995, based on long-term average harvests. Regulations limiting gear were established in 1997, including a mesh size of 1 ¾-inch (44.5 mm) and two categories of pot configuration, 'large' and 'small' with associated pot limits of 100 or 140, respectively, were defined by regulation in 1997. The implementation of GHR's has led to more proactive management, with inseason monitoring of catch and closure of districts by emergency order. However, this approach has inherent risks. There may only be a weak relationship between historical and sustainable harvest levels, particularly under changing environmental and ecological conditions.

Conservation concerns include prolonged holding and discard of small shrimp while fishers process the catch, under-reporting and non-reporting of catch, and the ineffectiveness of mesh size regulations in protecting small shrimp when pots are fished for short periods and pulled frequently. Spot and coonstripe shrimp are protandric hermaphrodites, changing into females, as they grow larger. Since the harvest is primarily of larger shrimp, removal of these females may affect the reproductive potential of the stocks. Long-term effects on recruitment and stock strength due to this harvest approach are not known.

Spot shrimp may be fairly long-lived. In Unakwik Inlet, Prince William Sound, they have been reported to live in excess of 7 years in age (A.T. Kimker et al. 1996). This species may also be fairly sedentary within suitable habitat; tag recoveries made over a 3-year period were all made within 0.9 mile (1.7 km) of their release site in Unakwik Inlet. In addition, a patchy spatial structure of acceptable habitat may result in aggregated spot shrimp populations that may be more vulnerable to serial depletion, particularly for those stocks near fishing ports, or within isolated fjords that have good fishing grounds (J.M. Orensanz et al. 1998). Long-lived, sedentary species having a patchy spatial distribution may require more conservative management in order to protect stocks from over-harvest.

This report provides a summary of the information collected during surveys, conducted seasonally prior to (preseason), and following (postseason), the commercial fishery in 4 districts of Southeast Alaska from 1996 to 2002. Survey protocol development continues to evolve as assumptions are evaluated and methods are refined. A goal of the pot shrimp survey program is

to accurately estimate population size and harvest rates in two statistical areas of each district surveyed. Such information may be used to adjust GHRs currently established for this fishery to achieve a sustainable harvest. Although this report documents all years of data collection to date, there remain several important questions regarding shrimp life history, appropriate harvest rates and pot recruitment dynamics. Continued study in these areas will help develop sound harvest rate based management of this fishery.

Objectives

1) Estimate a preseason index of abundance within each district surveyed, in order to evaluate interannual trends in population size.
2) Estimate the postseason index of abundance, for each surveyed area in order to estimate harvest rate and preseason population size. A statistical model being developed for this purpose will be summarized in a subsequent Regional Information Report (RIR) (J.E. Clark In prep).
3) Describe the size and sex composition of spot shrimp in each district surveyed, in order to determine spot shrimp relative size class strength.

METHODS

Pandalid shrimp species *P. platyceros* (spot shrimp), *P. hypsinotus* (coonstripe shrimp), *P. eous* (Alaskan pink shrimp), *Pandalopsis dispar* (sidestripe shrimp), and *P. tridens* (yellow leg shrimp) were captured using longlined conical pots set by an Alaska Department of Fish and Game (ADF&G) or chartered commercial vessel. Surveys lasted from 5 to 10 days depending on the year and management unit (district) surveyed. Each survey covered at least two adjacent statistical areas within a district, thus minimizing vessel running time while still covering a relatively large area. Also, statistical areas chosen were relatively protected from so that fishing time lost due to poor weather conditions was minimized. Those statistical areas having the highest average catches were surveyed. Prior to determining longlined pot set locations, one or more successful commercial harvesters who operate in each district were interviewed to identify areas of highest spot shrimp abundance. Within these areas, twelve set start locations along the 50-fathom (90 meter) isobath were chosen using a systematic sample design with randomly chosen start points (S.K. Thompson 1992) Arcview Geographic Information System (GIS) was used to delineate the 50-fathom line. This resulted in sampling locations centered at approximately the 50-fathom isobath, but crossing the 30 to 70-fathom (55 to 128 meters) isobaths. In all districts, during the second or third year of survey, the less productive sets were eliminated and set start locations were established in the most productive habitats only. These new locations became the 'index' set locations that were fished each year. The objective of establishing index set locations was to minimize the variability in catch rates due to habitat quality in order to better evaluate interannual trends in the shrimp populations.

Districts 3, 7, 12 and 13 were chosen to survey because they generally support the largest commercial harvest of spot shrimp within the respective larger management areas of Ketchikan, Petersburg, Juneau, and Sitka. Survey areas, in decreasing order of commercially harvested pounds, are District 3, District 7, District 13, and District 12. Statistical areas 103-23, and 103-25, in District 3 were surveyed from 1997 - 2003. Statistical areas 107-20, 107-30 and 107-40 in District 7 were surveyed from 1996 – 2003 and 107-10 was surveyed in 1996. Statistical areas 112-41, 112-42, 112-45 and 112-48 in District 12 were surveyed in 2000, 2002 and 2003. Statistical areas 113-55, 113-57 and 113-58 in District 13 were surveyed from 1999 – 2003 (Figure 1).

1996 Pilot Study - District 7

The first ADF&G pot shrimp stock assessment survey was conducted in District 7 in 1996. Its primary objective was to test gear in order to establish a standard method with which to survey shrimp stocks harvested by the pot fishery. A variety of setting styles, pot types and mesh sizes were tested (J.E. Clark, In prep). These included individual pyramid pots with a 4 by 4 foot (1.2 by 1.2 m) base, and two types of longlined cone pots; one 42 inches (106 cm) in diameter with 1 1/8- inch (28.6 mm) mesh and four tunnels (referred to here as "small mesh" pots), the other 42 inches in diameter with 1 ¾-inch (44.5 mm) mesh and three tunnels ("large mesh" pots). The large, individually set pyramid pots were time consuming to set and retrieve and did not fish well. The result was that fewer pots could be fished. The longlined cone pots proved easier to set and retrieve. Mesh size comparisons indicated that conical pots with 1 3/4-inch mesh provided the greatest power to detect differences in the density of shrimp recruited to the commercial fishery. It was also determined that ten 10-pot strings of the smaller, conical pots spaced 20 fathoms (36 m) apart on a longline could be easily set and retrieved in a day. Subsequently a spacing interval of 10 fathoms was established to mimic that of commercial gear. Based on comparisons of catch rates, this pot spacing seemed to be adequate to minimize effects of adjacent pots attracting shrimp from one another, thus providing discrete samples of shrimp within the fished habitat for any given pot within a string.

1997 Survey - District 3

In 1997, a survey of District 3 was conducted aboard a commercially chartered vessel in order to allow for cost recovery of the shrimp captured. Five statistical areas were surveyed, 103-21, 103-23, 103-25, 103-30, and 103-40 (Figure 1). Longlined cone pots were used, including 30 each of the 42-inch diameter large (L) and small (S) mesh cone pots tested during the 1996 pilot study and described above, and 90 of the charter vessel-owned (V), 38-in diameter, 1 ¾-in mesh, 3-tunnel cone pots. Ten longline strings with 15 pots each were arranged identically, interspersing pots at a spacing of 10 fathoms, as follows: VVLVSVLVSVLVSVV. This ordering was chosen to intersperse pots in a systematic fashion, and to put the large and small mesh pots away from ends where pots are most likely to fish poorly. Pots were baited with bait

jars filled to capacity with approximately 0.75 lb (0.34 kg) of chopped herring and hanging bait equivalent to 1/3 of a chum salmon or 1/2 of a pink salmon. Pots were snapped onto groundline.

At the beginning of the survey, ten 15-pot longlined sets were pulled daily, but by day three it was necessary to reduce effort to six sets daily. Depths from 26 to 75 fathoms were fished. Sets were spaced at 1/4 to 1/2 nautical mile intervals along the 50-fathom isobath. Pot sets were pulled daily and immediately re-set to achieve a mean soak time of 22.5 hours.

Biological Sampling

Pot contents were sorted by species; bycatch was counted, recorded and released. The total weight of spot shrimp in each pot was measured to the nearest 0.01 kg using an Ohaus electronic balance. For each set, a total of six of the 15 pots, two of each type, were randomly selected for sampling. Large catches were sub-sampled by number or weight for carapace lengths, parasite load, shell hardness and egg condition.

Data was collected for: shrimp carapace length (CL) to the nearest 1.0 millimeter (mm), presence or absence of eggs and parasites, soft-shell condition, and percentage of dead eggs for ovigerous females. Approximately 50 spot shrimp of a range of sizes were collected daily for later determination of sexual stage. These shrimp were sexed (D.L. Hoffman 1972) upon return to port. These shrimp were also measured to the nearest 1.0 mm carapace length, and whole and tail weights measured to the nearest 0.1 gram (g).

In addition, for Hetta Inlet, statistical area 103-25, a total of 122 unfrozen spot shrimp with and without eggs were sampled from each of eight 5-mm size intervals ranging from 20 to 60 mm carapace length. These were measured for carapace length to the nearest mm and whole and tail weight measured to the nearest 1.0 g.

1998 – 2003 Surveys - Districts 3, 7, 12, and 13

Index Set Locations

Twelve statistical areas in 4 districts were surveyed during 1998-2002: 103-23, 103-25, 107-20, 107-30, 107-40, 112-41, 112-42, 112-45, 112-48, 113-55, 113-57, and 113-58 (Figure 1). Survey effort distribution for all pre- and postseason surveys to date, and for all survey years and statistical areas surveyed is summarized in Table 1. To reduce variability in the catches due to differences in habitat type, index longline set locations were established in 1998 for the District 3 preseason surveys. Standard soak periods, baiting protocols, index set locations and data collection methods began with the September 1999 preseason surveys for Districts 3, 7 and 13, and with the 2000 preseason survey for District 12. Prior to standardization, index set start locations were chosen systematically using Arcview GIS with a random start along the 50-fathom isobath. Index set locations were targeted within known spot shrimp habitat. Each set was deployed from shallow to deep in order to sample 30 to 80 fathom depths. In the field, set start locations were adjusted by moving perpendicularly to the shore to the appropriate depth.

The set start and end coordinates were recorded using differential geographical positioning systems (DGPS) and during subsequent pre- and postseason surveys have been duplicated as precisely as possible given wind and current conditions.

Sample Gear Setting and Retrieval

For each longlined pot set, the following data were collected: the latitude and longitude coordinates for each end of the set, date and time setting began and ended, the order in which the beginning and ending buoys were set, the number of pots, set length, distance between pots, and the set depths of the first, fifth (middle), and last pots.

During each survey, six longlined sets of ten 42-in diameter conical pots were soaked 20-24 hours and pulled two times in each of the statistical areas surveyed. Half of these pots were large mesh pots while the other half were small mesh pots. Small and large pot types were snapped onto neutrally buoyant marked groundline alternately at 10-fathom spacing. Each pot was baited with 2 pints of chopped herring and either 1/3 of an in-the-round chum salmon or 1/2 of a pink salmon. Bait was not thawed more than 12 hours prior to use.

Before pulling a set, the coordinates given by DGPS for each end of the set were compared to that recorded during setting by running nearby each buoy and noting its location and number. If the set had drifted or was in a location significantly different from where it was set, the coordinates at the time of pulling were used instead of those recorded during setting. The date and time pulling began and ended, and the bottom type as indicated by mud, coral, glass sponge or gravel on the pot or longline was noted.

Biological Sampling

Species Composition Sampling

For each set, three small mesh pots and three large mesh pots (excluding the end pots) were randomly selected for sampling. Sampling was conducted either during pulling or between set pulls depending upon the vessel deck configuration. For each sampled pot, the contents were first dumped into a basket pre-labeled with pot order. Non-shrimp bycatch species were removed, identified, and counted. The total weight of all bycatch species was recorded, when time allowed. All shrimp were sorted by species, measured, counted and weighed.

Carapace Length Frequency Sampling

Carapace lengths of spot, coonstripe, Alaskan pink, and sidestripe shrimps were measured to the nearest 0.5 mm. If the catch in a sampled pot was small, carapace lengths on all shrimp caught were measured. Large catches of shrimp were sub-sampled at rates ranging from 1/2 to 1/15 of pot contents. Shrimp were usually sub-sampled by number but were sub-sampled by weight when pot contents became prohibitively large for counting. The presence or absence of eggs and parasites, soft-shell condition, and percentage of dead eggs on ovigerous females were noted for all sampled spot and coonstripe shrimps.

Carapace, Whole and Tail Weights of Spot Shrimp

Each day, carapace lengths, whole weights and tail weights to the nearest 1.0 g for a sample of up to 10 spot shrimp with and 10 without eggs, from each of eight 5-mm size categories ranging from 20 to 60 mm CL were measured. In order to sample the entire size range, shrimp were collected throughout the day, from a combination of sampled pots and sets. Shrimp were held on ice or refrigerated and measured at the end of the day, while at anchor. Weighing samples onboard while at anchor minimized the effects of boat motion on variable scale readings.

Sex-at-size Samples

Each day, two randomly selected grab samples of approximately 50 shrimp each, were taken from two unsampled pots for later determination of sexual stage by ADF&G staff. Pots at the ends of each survey string were not sampled, as these end pots had more variable catch rates and size composition than the other pots in the string. During two of the District 7 surveys, shrimp samples were sexed onboard.

RESULTS

Results presented in this report include summaries of catch and catch per unit effort, length frequency histograms, mean, minimum and maximum sizes of egg-bearing and non egg-bearing shrimp and summaries of average catch per pot and proportion of bycatch species for all areas surveyed, all survey years and all mesh sizes fished. Trends in abundance by size of shrimp are evident, as are observed changes in size distribution for District 3 index set locations and may provide some insight about relative abundance by size in survey catches elsewhere in Southeast Alaska. Data collected from surveyed areas where standard set locations have not been established have been summarized, however, any trends in the data within these areas should be viewed cautiously, as differences in habitat and oceanographic conditions may introduce an unknown amount of variability to the data. Likewise, only general statements can be made when comparing districts. For the purposes of this report, only longlined shrimp pot sets soaked for approximately twenty-four hours have been analyzed, except where noted in the summary tables. For all districts, the number of discrete longlined sets of shrimp pots varied for all surveys from 4 to 18 with between 20 and 120 pots being sampled per area (Table 1). Pots 1 and 10 (1998-2001) were eliminated from analysis of District 3, 12 and 13 surveys as these pots often had more variable catch rates than pots located towards the middle of the longline. Although a similar phenomenon existed for District 7, all pots in the longline set were sampled to meet sampling goals, as overall shrimp abundance was lower. The results presented focus primarily on spot shrimp populations, except in District 7, where coonstripe as well as spot shrimp are commercially important.

The estimated total number of spot and coonstripe shrimp that were captured during the survey and the total number of shrimp of these species sampled for all districts and years of survey are given in Table 2. An estimated 460,000 spot shrimp have been captured during pre- and postseason pot shrimp surveys in Southeast Alaska since 1996. Of those, about 119,000 have been measured, weighed, sexed, noted for presence or absence of eggs, checked for parasites and examined for shell condition. Sampled shrimp were captured in a total of about 4,500 sampled

pots. This represents a mean sub-sample rate of approximately 20% of all shrimp captured. Other Pandalid shrimp species captured included the Alaskan pink shrimp, sidestripe shrimp, yellowleg pandalid, dock shrimp, *Pandalus danae*, humpy shrimp, *Pandalus goniurus,* and the Hippolytid shrimp, the spiny lebbeid, *Lebbeus groenlandicus* (Table 3, Table 4a).

Non-shrimp bycatch species of commercial importance in order of frequency of capture were Tanner crab, *Chionoecetes bairdi*, Box crab, *Lopholithodes foraminatus,* Walleye Pollock, *Theragra chalcogramma*, Pacific red octopus, *Octopus rubescens,* Red King Crab*, Paralithodes camtschaticus,* sablefish, *Anoplopoma fimbria,* Pacific cod, *Gadus macrocephalus,* and Yelloweye Rockfish, *Sebastes ruberrimus*. Other, non-commercially important species captured in survey shrimp pots, in order of approximate decreasing numerical abundance included species such as squat lobster, *Munida quadrispina*, lyre crabs, *Hyas lyratus,* decorator crabs, *Oregonia gracilis,* hermit crabs*, Pagurus* spp.*,* hairy fusitriton, *Fusitriton oregonensis*, and *Buccinum* spp. snails, fish-eating starfish, *Stylasterias forreri,* sunflower stars, *Pycnopodia helianthoides,* sculpins (family Cottidae)*,* and Quillback Rockfish, *Sebastes maliger.* Forty-six bycatch species for all years, surveys, mesh types and areas fished were identified, approximately half of which had a prevalence exceeding 1 percent (Tables 4a, 4b and 4c).

District 3

For all years surveyed approximately 204,895 shrimp are estimated to have been caught using 1005 pots fished during preseason surveys from 1997 to 2003 and 91,364 shrimp from 514 pots fished during postseason surveys in District 3 from 1998 to 2002. Of these, about 40,000 were handled during preseason surveys and about 21,700 during postseason surveys, or a mean of about 18 percent (1 in 6 shrimp) of the catch for preseason and 24 percent (about 1 in 4 shrimp) for postseason surveys (Table 2). A mean of 29,271 shrimp were captured during preseason and 22,841 during postseason surveys.

Alaskan pink shrimp were commonly captured in survey pots, as were a number of other species of non-commercially important shrimp including species such as the spiny lebbeid, *Lebbeus groenlandicus* (Table 3, Table 4b). Tanner crab, *Chionoecetes bairdi*, squat lobster, *Munida quadrispina*, decorator crab, *Oregonia gracilis*, hermit crab, *Pagurus* spp., box crab, *Lopholithodes foraminatus*, and lyre crab, *Hyas* spp., were the most prevalent crustaceans with Pacific Octopus, *Octopus dolfeini* and sponges also represented in the catch from survey pots for District 3 for all years surveyed. Sablefish, *Anoplopoma fimbria*, Quillback Rockfish, *Sebastes maliger*, and Walleye Pollock, *Theragra chalcogramma*, were the most abundant fish species. *Buccinum* spp. snails and corals were not prevalent (Tables 4a, and 4b). In total, 43 separate taxonomic groups are represented in catches from District 3 surveys, with 14 species prevalent greater than 1% of total bycatch species.

Spot Shrimp

Catch Rates

Mean and standard error of soak time (hrs), weight of catch (kg), numbers caught, weight (kg) per hour, number per hour, and total number of pots sampled were tabulated for pre- and postseason surveys from 1996 to 2003 for all of District 3 and separately by statistical area (Tables 5a, 5b, and 5c). The preseason survey soak times averaged 22.7 hours for small and large mesh pots for all years of the survey. A mean of 60 pots of both mesh types were sampled annually during surveys in District 3. The mean catch was 5.7 (+/- 3.1) kg or 217 (+/- 128) shrimp for small mesh pots and 4.4 (+/- 2.7) kg or 127 (+/- 83) shrimp for large mesh pots. On average, 0.25 kg or 9 animals per hour were captured in small mesh and 0.19 kg or 6 animals per hour in large mesh pots (Table 5a).

Postseason soak times have also averaged 22.2 hours. A mean of 55 pots were sampled annually during postseason surveys. Mean catch rates and variability of mean catch rates were lower than during preseason surveys, 4.4 (+/- 2.6) kg or 197 (+/- 119) animals and 3.4 (+/- 1.9) kg or 113 (+/- 66) animals respectively for small and large mesh pots. Small and large mesh pots respectively caught 0.20 kg or 9 shrimp per hour and 0.15 kg or 5 shrimp per hour (Table 5a).

Interannual trends in changes in abundance during preseason surveys are not apparent in District 3 when statistical areas 103-23 and 103-25 are combined (Table 5a). All catches by weight and number vary within the range of variability observed for all years of survey. Also, no clear trends are evident for pre- and postseason catch rates if the two surveyed statistical areas are considered separately (Table 5b and 5c; Figure 2). However, preseason survey catch rates, in terms of both number and weight for both small and large mesh pots were generally greater than postseason survey catch rates. The overall variability around the mean number and weight of shrimp caught was greater for small mesh as compared to large mesh pots, as small mesh pots catch more total shrimp (Tables 5b and 5c, Figure 2). Variability in catch rate was generally greater for pre than postseason surveys.

Size Composition

Statistical area 103-25 was the only area that was sampled preseason in District 3 during 2003 due to foul weather. No postseason survey was conducted. The bi-modal length frequency histograms for 2003 indicate shrimp populations of similar size composition and relative abundance as those observed during 2002 in 103-25 (Figure 3, Figure 4c). As observed during 2000, 2001 and 2002, the median carapace length appears to be centered at 31 to 32 mm. A few larger than normal sized shrimp were captured during the 2003 survey, shifting the right tail of the distribution (Figure 3). Preseason shrimp catches from 1998 to 2002 consisted of more large shrimp than postseason (Figures 4a, 4b, and 4c). Dominant size classes also appear to be detectable and may be able to be tracked through time, and possibly through removal by the fishery. A large size-class of smaller shrimp were present in 103-23 and 103-25 during 2000 and 2001 (Figures 4b, 4c).

In order to quantitatively describe interannual trends in shrimp size, we calculated the mean carapace length (CL), variability in carapace length, minimum and maximum size and proportion of ovigerous and non-ovigerous shrimp (Table 6). Declines in mean carapace length for shrimp captured during preseason surveys are not evident, however, analysis of postseason survey data

indicate declines in mean shrimp size for the 1998-2003 period (Table 6). All of these differences are within the range of variability observed (Figure 5).

The preseason survey underestimates the proportion of egg-bearing females as the survey coincides roughly with the onset of egg-extrusion. Thus, variability in this proportion is more likely to be related to the survey timing. All preseason surveys were conducted during the second week of September for 1997-2003 except during 2001 when the survey was conducted during the third week of September. The proportion of females that were egg-bearing during postseason surveys from 1998-2001 appears to be similar between years, for both statistical areas, indicating that egg extrusion was mostly complete by the time postseason surveys were conducted (Table 6). Over the last three years, data from postseason surveys indicate a general decrease in the mean carapace length of egg bearing shrimp for each of the statistical areas surveyed. Again, all differences are within the standard deviation of the mean (Figure 5). No trends are evident in minimum and maximum sizes for egg-bearing females for the years surveyed (Table 6).

Trends in the catch rates of commercially exploitable shrimp (>36 mm CL, the smallest size found to be retained by commercial gear) are apparent when compared to shrimp smaller than 36 mm CL. Catches by weight and by proportion of total catch are increasing for small shrimp and decreasing for large shrimp for 1998 to 2003 for both mesh types fished. Declines in catches of larger shrimp are evident in postseason surveys as well, but appear to be evident one to two years before declines are evident in preseason surveys. An increasing number of small shrimp appear to be retained each season by the small mesh pots than are retained by the large mesh (Figures 6a, 6b, 6c).

District 7

A cumulative total of 998 pots have been sampled during preseason fishery surveys with an additional 536 pots sampled in 2001 and 2002 during postseason surveys. A mean of 166 pots were sampled per statistical area in District 7 preseason surveys. A mean of 130 pots were sampled during postseason surveys (Table 1). Approximately 30,200 spot shrimp have been captured in Ernest Sound since preseason surveys began in 1996, for a mean of 5,033 spot shrimp. About 50% of these shrimp have been sampled for biological data. A total of approximately 11,700 coonstripe shrimp are also estimated to have been captured, of which about 5,600 or about 60 percent have been sampled for biological data. A mean of 1,957 coonstripe shrimp were captured each survey pre- and postseason combined (Table 2). The two statistical areas of district 7 that support much of the commercial harvest of coonstripe shrimp taken from this district, 107-20 and 107-40 have been consistently surveyed since 1996.

Invertebrates captured during the District 7 survey included: Alaskan pink shrimp, sidestriped shrimp, humpy shrimp, (Table 3), squat lobster, Tanner crabs, hermit crabs, Pacific octopus, lyre and box crabs, starfish, and sea urchins. The most common fishes included: sculpins and the occasional Quillback Rockfish or Walleye Pollock (Table 4a, 4b). Sablefish were not as common as in District 3. Sponges and corals were not commonly reported. Thirty-two separate taxonomic groups are represented from surveys of Ernest Sound since 1996. Nine species were prevalent at levels greater than 1% of the total bycatch species.

Spot Shrimp

Catch Rates

Mean and standard error of soak time (hrs), weight of catch (kg), numbers caught, kg per hour, number per hour, and total number of pots sampled were tabulated for pre- and postseason surveys from 1996 - 2003 for all of District 7 and separately by statistical area (Tables 7a, 7b, and 7c). The preseason survey soak times averaged about 18.5 hours for small and large mesh pots for all years of survey. The mean catch was 1.1 (+/- 0.06) kg or 45 (+/- 42) shrimp for small mesh pots and 0.8 (+/- 0.05) kg or 28 (+/- 27) shrimp for large mesh pots. Average catch rates were 0.06 kg or 2 animals per hour were captured in small mesh and 0.05 kg or 1 animal per hour in large mesh pots (Table 7a).

Postseason soak times averaged soak times of 19.7 hours. A mean of 105 pots were sampled annually during postseason surveys. Mean catches were lower than during preseason surveys. Respectively, 0.68 (+/- 0.03) kg or 16 (+/- 26) animals and 0.60 (+/- 0.03) kg or 12 animals (+/- 15) wee caught in small and large mesh pots. Small and large mesh pots both caught 0.03 kg or 1 shrimp per hour (Table 7a).

Detection of annual trends in shrimp catch rate for District 7 is complicated by the fact that only since 2000 have the same three statistical areas been consistently fished. Average catch rates averaged for the statistical areas 107-20, 107-30, and 107-40 do not differ significantly for preseason surveys for the period 2000 to 2002 (Table 7a; Figure 7). Postseason surveys in District 7 were conducted during 2001 and 2002. Postseason mean catch rates, district-wide for all years of survey, were approximately half what was caught during preseason surveys both by kg and number, however, this difference is not significant (Tables 6c, and 6d; Figure 7). Variability in catch rates was also slightly higher for preseason surveys as compared to postseason by both weight and number (Table 7a; Figure 7). Mean catch and variability about the mean by weight and number were highest in 107-10 during 2003 (Table 7c).

Size Composition

Two predominant size classes of shrimp were captured in District 7 during the 2003 surveys, with a mode at 23 mm and 33 mm CL. Length frequency histograms for the entire district and for 107-20 show different structure, indicating that the small size classes were more prevalent in 107-10 in 2003 (Figure 3). This contrasts with 2002 histograms, which have modes at approximately 28 mm and 36 mm CL (Figure 8a). However, 107-10 was not surveyed in 2002, but 107-30 and 107-40 were. These areas are further north and east into the fjord, which may be less than optimal habitat for smaller shrimp. In fact, all histograms for the 1999-2002 period are shifted towards the larger shrimp than lengths collected during 2003.

More large shrimp were captured during preseason surveys than postseason in District 7 during the 2001 and 2002 season (Figures 7a and 7b). However, this “fishing-down” effect is much less noticeable than for District 3. Small mesh pots appear to catch at least one additional size class of pre-recruit shrimp, which the large mesh pots let escape (Figure 8b). Up to three separate size-classes may be evident during most survey years, such as in 2001 for statistical area 107-20

(Figure 8b). Shrimp minimum and maximum carapace lengths are generally larger than those from District 3. In fact, predominant size classes appear to be larger in District 7 by 5 to 10 mm in carapace length than those shrimp from District 3.

In order to quantitatively describe interannual trends in shrimp size, we calculated the mean length (CL), variability in length, minimum and maximum size and proportion of ovigerous and non-ovigerous shrimp (Table 8a; Figure 10). While shrimp minimum and maximum carapace lengths are generally 5 to 10 mm larger than in District 3, there is no apparent change in mean carapace length of shrimp captured from 1999 to 2003 during preseason and postseason surveys (Table 8a; Figure 10). However, mean carapace length in 1996 was generally larger than in subsequent years. There do not appear to be any changes in minimum and maximum carapace lengths or proportion of egged females (Table 8a).

The proportion of larger shrimp captured in District 7 is declining, but more of the larger shrimp than the smaller are still being captured in the commercial mesh pots. Approximately equal proportions of large to small shrimp were captured during 2003, 55% large to 45% small (Figure 11). The proportion of large shrimp captured in all areas and mesh types is lower for 2003 as compared to 1996.

Coonstripe Shrimp

Catch Rates

The preseason survey catches for 1996, 1999, 2000, 2001, and 2002 averaged for all statistical areas surveyed were 0.33 (+/- 0.36) kg or 22 (+/- 19) shrimp for small mesh pots and 0.35 (+/- 0.34) kg or 17 (+/- 17) shrimp for large mesh pots. Catch rates were 0.02 kg or 1.2 animals per hour were captured in small mesh and 0.02 kg or 0.9 animals per hour in large mesh pots (Table 7b).

Coonstripe catch rates during postseason surveys were 33% to 50% by weight of preseason surveys (Table 7b, Figure 9a) for both large and small mesh pots. Means for the 2001 and 2002 postseason survey catches was 0.18 (+/- 0.21) kg or 9 (+/- 10) animals and 0.18 (+/- 22) kg or 7 (+/- 8) animals for small and large mesh pots. Small and large mesh pots, respectively, caught 0.01 kg or 0.5 shrimp per hour and .01 kg or 0.3 shrimp per hour (Table 7a, 7b). Variability also declined postseason for both mesh sizes.

Size Composition

Preseason survey length frequency comparisons show the value of using small mesh pots to identify pre-recruit strength in the population. At least one smaller size class appears to be present in all years in small mesh pots as compared to large mesh during preseason surveys (Figure 9b). Commercial mesh sizes may provide excellent escape opportunities for smaller shrimp, as evidenced by the size distribution taken in small mesh pots. However, even in small mesh pots, catch rates postseason are dramatically different than preseason (Figure 9a).

District 12

Tenakee Inlet has been surveyed during September of 2000, 2002 and 2003. During these surveys, a cumulative total of 479 pots were set in four different statistical areas for a mean of 40 pots per area. An estimated total of 66,399 spot shrimp and 5,305 coonstripe shrimp were captured during these preseason surveys. This equates to a mean of 22,133 spot shrimp and 1,768 coonstripe caught per survey. Of the spot shrimp, 25 percent (16,835) were measured (Table 2). This area supports a lucrative, fast-paced fishery with a guideline harvest level of 20,000 lbs of fairly large-sized shrimp typically harvested in one week or less.

Based on the bycatch species composition, Tenakee Inlet may hold a different type of habitat than the other surveyed areas. Thirty-one taxonomic groups have been identified during survey (Tables 3a, and 3c). Invertebrates most commonly captured during the District 7 survey included Alaskan pink and humpy shrimps (Table 3), a variety of crabs including lyre and decorator crabs, hermit and scale crabs and several types of snails including predominantly Hairy Fusitriton and Buccinum species. Silaceous and soft sponges as well as corals are more prevalent than in other surveyed districts. Fish species encountered include sculpins and pollock (Table 4c). Bairdi Tanner crabs and Pacific octopus were not as prevalent as in other districts surveyed.

Catch Rates

During the period surveyed, catch in numbers and by weight has increased in District 12 indicating a greater abundance of smaller shrimp (Figure 12). A mean of 5.1 (+/- 2.4) kg or 68 (+/- 7) shrimp were caught in small mesh and 4.2 (+/- 2.7) kg or 45 (+/- 4) shrimp were caught in large mesh pots (Table 9a). All statistical areas surveyed had strong catch rates in Kg per pot, which generally increased through time for both mesh sizes fished.

Catch in kg per pot-hour for this area was comparable to the high catch rates observed in District 3, but with fewer shrimp caught than in District 3, the size is comparatively larger (Table 9a). Postseason surveys have not been conducted.

Size Composition

In general, Tenakee Inlet shrimp were larger in size in 2000 as compared to other survey areas with mean size for egg-bearing shrimp of 44.7 mm and 35.1 mm for non egg-bearing. Mean of egg bearing shrimp measured in 2002 was 45.2 mm and 33.0 mm for non egg-bearing shrimp (Table 10a). Mean sizes for 2003 are generally smaller than previous years. Trends in mean, minimum and maximum sizes as depicted using summary tables are difficult to visualize as some statistical areas show decreases in average size and some show increases (Table 10a). Length frequency histograms for shrimp captured in 2003 in Tenakee Inlet are unimodal around 35 mm CL (Figure 3). By comparison, histograms collected for samples from the same set locations for 2000 and 2002 show two or three predominant size classes of shrimp, dominated by the largest size classes having modes centered at 40 and 45 mm carapace length (Figure 13). Depicted graphically for the entire district, the mean catch in numbers and by weight has increased each season (Figure 12), while mean carapace length has decreased (Figure 14). This indicates an increasing abundance of smaller shrimp through time.

Whereas larger, commercially available shrimp comprised 80% of the catch in 2000, these larger shrimp are proportionately less abundant in 2003 at 60 to 70% of the catch (Figure 15). This trend is evident for both large and small mesh pots fished in District 12 prior to the commercial season.

District 13

Hoonah Sound has been surveyed preseason from 1999 to 2003. A cumulative total of 692 pots have been sampled in District 13, with a mean of 46 pots sampled per statistical area surveyed (Table 1). These pots caught a total of about 63,212 spot shrimp, of which 32 percent (20,235) were sampled (Table 2). This averages to about 12,642 spot shrimp and 2,260 coonstripe shrimp caught each survey. Approximately 11,000 coonstripe shrimp were caught during surveys, of which about 25 percent were sampled. District 13 has similar catch rates during survey to District 7 for coonstripe shrimp relative to spot shrimp.

Non-target shrimp species captured during the surveys in order of decreasing abundance included Alaskan pink, and sidestripe shrimp (Table 3). Non-shrimp bycatch taxonomic categories identified from surveys in District 13 total 24 different groups (Table 2). Comparing those species prevalent at levels of at least 1 percent, Hoonah Sound survey catches contained more lyre and decorator crabs as well as the ubiquitous squat lobster. Snails, hermit crabs and Tanner crabs were also captured in small numbers. Walleye pollock, sculpins and an occasional Quillback rockfish represent the fishes captured by survey pot gear (Tables 4b and 4c).

Catch Rates

Catch rates by weight and number have increased during the 1999-2003 period in District 13 (Table 9a). In fact, more biomass of shrimp was captured in two of the three areas for both mesh sizes fished in 2003 than all previous years (Table 9c). Survey gear was fished in all statistical

areas of District 13 a mean of 21.1 hours, capturing a mean of 3.7 (+/- 2.6) kg for small mesh and 3.1 (+/- 2.2) kg for large mesh pots. Catch rates ranged from 3.2 to 4.6 kg in small mesh pots and 2.5 to 3.9 kg in large mesh pots. Small mesh pots caught a mean of 0.2 kg per hour while large mesh caught about 0.1 kg per hour. A mean of 5 and 4 shrimp were caught per hour in small and large mesh, respectively (Table 9a). Mean catch in numbers and by weight for each season vary within the range of variation observed (Figure 16). No post-season surveys were conducted in District 13.

Size Composition

There are no directional trends in mean carapace length evident over the survey period, 1999 – 2003. Mean carapace lengths for all surveys varied within the range of variation observed (Table 10b, Figure 18). There were no trends in mean, minimum and maximum sizes. Mean carapace lengths for egged and unegged shrimp were remarkably similar for all years of survey (Table 10b) Egg-bearing and unegged shrimp are slightly larger on average than District 3 and similar in size when compared to the other districts surveyed. The proportion of egged females is fairly consistent for all survey years, areas and mesh sizes (Table 10b).

Length frequency analysis for District 13 indicates continued strong production of two or more size classes of shrimp for the 1999 through 2003 period. Production of numerous size classes in this area seems to be being sustained in 2003 (Figure 3). The size composition of shrimp captured during the 2002 survey in District 13, Hoonah Sound, had three or possibly four modes, while at least two modes are evident for 2003 (Figure 17). Although removal of shrimp over 40 mm CL may be evident, abundant smaller pre-recruit shrimp appear to be present (Figure 3). Similar proportions by weight (20%) of small (< 36 mm CL) and large (> 36 mm CL) shrimp (80%) were sampled in large mesh pots in 2003 as compared to 1999 (Figure 19). More, smaller shrimp were evident in small mesh pots during 2003 as compared to 1999, indicating continued healthy production of smaller shrimp.

DISCUSSION

Discussion of these survey results needs to be prefaced with an assessment of potential sources of variation in the data collected and the assumptions made during analysis. Catch rates and estimates of size composition may be influenced by variables such as magnitude of the tides, potential migration into and out of the survey area, differences in habitat, quality and quantity of the bait, selectivity of the different mesh types fished, and length of the soak period. To account for these variables, preseason surveys were scheduled to occur during mid to late September each year prior to the commercial fishery and were conducted using standardized baiting, setting and soak period protocols and randomly selected, yet repeatable set locations. For each area surveyed a mean subsample rate of at least 25% of total catch of shrimp was used. This allowed precise estimates of the size distributions present in the areas surveyed. Smaller sub-sample rates should improve precision, and are recommended where possible. Quantitative assessment of the effects of mesh selectivity on the rate of retention of different sized shrimp and further

experimentation on the effects of differing soak periods on catch rates and size composition are currently being conducted (J.E. Clark In prep).

Some of the assumptions to be made when analyzing the results include:
1) the catch rate and total biomass captured in survey gear are reliable indices of the actual abundance of shrimp in the survey area,
2) the size distribution of shrimp caught in the various mesh sizes fished represents a definable sample relative to the true population being surveyed; i.e., catches of the different size classes of shrimp can be quantified and are relative to the size of mesh fished, and
3) the survey catch rates and size distribution in survey catches are representative of the stocks of shrimp available to the commercial fleet.

With these sources of variability and assumptions in mind, quantitative methods to assess the strength of shrimp stocks and to develop a quantitative index of abundance should allow more precise management. Threshold management currently used eventually could be adjusted appropriately based in part on survey data used to estimate relative stock strength and size composition of the stocks.

Variability in catches are provided as an indication of the range of catch rates by weight and number, thus may indicate relative strength of pre-recruit and recruit size classes sampled during surveys. Small mesh pots retain more of the smaller size classes and catches are more variable, while large mesh pots retain those shrimp of commercially valuable sizes available to the gear. While mean values indicate the midpoint of the sizes captured, variability in the catches may also change as abundance levels rise or fall, providing another measure useful for comparison. This information may provide the bounds, or confidence limits, of the catches by weight and number. Assuming that survey gear fishes in the same manner year to year, mean values and variability measures compared inter-annually should describe the relative abundance of the variety of sizes of shrimp available to the gear. Changes in variability may also indicate changes in abundance such as may occur in areas of localized depletion where catch rates are less consistent.

Finally, this analysis is still in development, considering that even in District 3 only six years of standardized data has been collected, a bare minimum time series for making conclusions about long-term trends. Comparisons of additional years of survey are needed to verify the conclusions made so far and identify additional possible trends. Given the uncertainly of the age of spot shrimp, which may be older than seven years, and the need to have multiple recurring cycles in abundance for comparison purposes, the conclusions reached so far should be considered as preliminary.

District 3

Species diversity attracted to the shrimp gear was slightly greater in District 3 than in other surveyed areas, although this may only be a relative measure of the actual diversity present within the sampled habitat. Glass sponge is reported with more frequency in District 3 and may

be evidence of a diverse, structurally complex bottom in this area. This complexity may provide the diversity of habitats needed to maintain the large numbers of smaller shrimp in this area.

Longline set locations representative of the shrimp habitat in a survey statistical area were first established in District 3 in 1997 and have been fished consistently since then, minimizing potential variability due to habitat effects and allowing for more believable comparisons between survey types and years. Abundant shrimp in the area maintain high catch rates even in pots fished for less than 1 hour (Love and Clark, Nearshore V Interrim Report 2003).

In District 3, large shrimp are being removed from the system and production of smaller shrimp is strong. In general, small mesh pots caught more shrimp of a smaller size than did large mesh during most surveys. Mean catches by weight, variability in mean catch by weight, mean number of animals caught and variability in mean numbers caught all appear to be similar or slightly greater for the small mesh pots when compared year to year. Presumably, removal of large shrimp by the fishery appears to allow abundant small shrimp to fill the pots, thus maintaining strong catch per unit effort. This trend is especially evident when catches are plotted by size class of shrimp. The proportion of large shrimp in District 3 catches has decreased since the 1998 survey in both statistical areas. Removals of larger shrimp are also evident when comparing preseason to postseason length frequency histograms.

The observed decreases in the preseason survey catch rate of large shrimp, proportion of large shrimp and mean carapace length since 1998 may be cause for concern. Since Pandalid shrimp are protandric hermaphrodites, a larger proportion of potential females are being captured prior to spawning (recruitment over fishing) and that the full value in terms of size of shrimp, pounds of harvest, and ex-vessel value may not be achieved as shrimp are being harvested before they have a chance to grow to a larger size (growth over fishing) (J.A. Boutillier and J.A. Bond 1999). This is especially problematic in this high-end market fishery since larger shrimp fetch a higher price per pound. Shrimp stocks in British Columbia are managed to attempt to avoid this by closing the fishery annually to achieve a March ‘spawner index’ of 1 female per standard pot (J.A. Boutillier and J.A. Bond 1999) and by a minimum size limit. This management regime has proved so successful in maximizing the value of the fishery that the size limit has been increased twice, once at the request of the commercial fleet.

Abundance of smaller shrimp may actually mask the removal of larger shrimp through time, complicating interpretation of catch rates by size category over time. Further soak time experiments will hopefully help to quantify relative catchability by size of the different sizes of shrimp and provide a better measure of the removal of larger shrimp. In situations where smaller shrimp are abundant and easily saturate a pot, it may be more useful to conduct postseason surveys for evaluating the abundance of larger shrimp, after more of the smaller shrimp have been removed.

Depending on water currents, upwelling conditions and larval retention gyres, shrimp stocks in Southeast Alaska likely should be considered part of a larger metapopulation. While localized depletion may remove adult shrimp from certain areas, eventually larval advection into the area may repopulate it. Likewise, similarities in oceanographic conditions may affect shrimp survival and growth rates similarly. The similarity in the mean size of shrimp and length composition

from 103-23 and 103-25 may indicate that stocks in these adjacent statistical areas may also mix and may be the same stock. Although spot shrimp are considered to be a relatively sedentary species, once they become adults, little is known about diurnal or diel migrations up- and downslope or intrannually.

District 7

Overall, the species diversity attracted to survey gear is slightly less than in District 3, although the species richness and makeup is fairly similar. More Alaskan pink shrimp are captured in this area than Districts 3 or 12 as some of the randomly selected survey pot locations are on sandy and silty bottoms. Squat lobster, a commercially important invertebrate in other parts of the world and Pacific octopus, a permitted commercial species in Southeast Alaska pot shrimp fisheries, were more prevalent in surveys conducted in District 7 than in catches from surveys in other districts (Table 4a).

Although surveys have been conducted in District 7 since 1996, comparable standardized set locations have only been fished in 107-20 since the 1999 survey. Low catch rates from 107-30 and 107-40 during 1999 through 2002 surveys necessitated modifying the survey again in 2003, adding set locations in 107-10 to bolster catch rates. Sets made in 107-10 in 2003 had better catch rates and less variability than other areas sampled during past surveys. Because catch rates were so low, the total number of sampled pots per string is greater and sub-sample rates are lower in District 7 than in District 3. These low catch rates, and changing set locations introduce greater variability in the catches, which makes analysis of District 7 data difficult.

Standard set locations appear to have been consistently fished in 107-20, allowing for an adequate quantity of sampled pots necessary for statistical analysis. Assuming that similar bottom communities were sampled and adequate sample sizes of shrimp were captured, comparisons between years may still be possible and may at least indicate possible trends for the entire district, if not indexed relative abundance.

All of these drawbacks aside, catch rates in terms of weight and numbers are consistently low in District 7 in general and in 107-20 in particular. Shrimp are larger in overall size than in District 3, with a mean carapace length and maximum carapace length that is more similar to Districts 12 and 13. Removals of spot and coonstripe shrimp by the commercial fleet are quite evident in comparisons of pre and postseason length frequency histograms, however, no trends in mean shrimp size during preseason surveys is evident. Likewise, mean size for large egg bearing, and small non egg-bearing shrimp appears to be similar for all years surveyed.

Comparisons of catch by size class are necessary to fully understand trends in CPUE during surveys. Although the declining trend in proportion of large shrimp for the 1999 to 2003 period appears to indicate a decrease in abundance of larger shrimp, further surveys using the same set locations established during 2003 are required to make a quantified judgement. The proportion of large shrimp currently being caught has declined since surveys were initiated, suggesting that growth and recruitment over fishing may be occurring for this district, however, this trend may instead be the result of changing set locations towards the areas closer to Clarence Strait. Length

frequency histograms for 2003 indicate that pre-recruit shrimp are present in District 7, however, certain areas (107-10) may be more important as 'nursery grounds' for the smaller shrimp than are other areas. Larvae may be more likely to be advected into 107-10 and 107-20 from Clarence Strait than into the areas further north, up the Ernest Sound fjord.

District 12

District 12 habitat appears to be different than the other surveyed areas, if the species diversity attracted to the pots is any indication. Shrimp bycatch included a fair number of Alaskan pink shrimp, and coonstripe shrimp, and non-shrimp bycatch including snails, possibly residing on the softer, muddy bottoms further up the inlet. Near the mouth of Tenakee Inlet, statistical area 112-41, a larger proportion of glass sponge and corals were noted on or in survey gear. Surveys have been conducted prior to each of the 2000, 2002 and 2003 commercial fisheries.

Generally, spot shrimp were larger in Tenakee Inlet than elsewhere and catches had a higher proportion of egg-bearing females during September preseason surveys than in other districts, indicating earlier extrusion of eggs than elsewhere. Catches by number were less than in District 3, but the total biomass per pot per hour was similar, indicating a larger overall mean size as compared to other surveyed areas. Multiple size classes are evident in the length frequency histograms for both survey years indicating good recruitment strength and abundance of harvestable size classes.

Egg-bearing shrimp sampled during the 2002 survey were slightly larger in length, on average, than during the 2000 survey, but proportionately less abundant. Slightly lower relative catch rates of shrimp larger than 34 mm CL in 2002 as compared to 2000 may be evidence of removals of larger shrimp from the area. Postseason surveys have not been conducted in Tenakee Inlet. While some decline in the proportion of catch by weight of larger shrimp is evident between 2000 and 2002 surveys, it is still greater than catches of small shrimp and was second only to District 13 of the surveyed areas. Catch rates are adequate for the number of pots fished in each of the statistical areas to provide adequate sample sizes.

District 13

Diversity of species captured in District 13 survey pots appear to be similar to those caught in Districts 3 and 7, indicating similar ecological community types. A fair number of coonstripe shrimp were captured in District 13 surveys and more corals and sponges were entangled than in Tenakee and Ernest Sound. Pacific octopus is not as abundant as in Districts 3 and 7, but was similar to District 12.

Set locations have now been established and repeatedly fished in District 13 since the 2001 survey. Surveys in District 13, like District 7, employ lower sub sample rates and a larger total number of sampled pots than in District 3. Coonstripe shrimp are abundant in this area as well, second in abundance only to the number caught in District 7. Catch rate in terms of weight is stable.

In District 13, the mean size of both large and small shrimp appears to be similar between years in those areas sampled. Survey sets result in adequate sample sizes. Catch rates are increasing in small mesh pots, while remaining stable for large mesh pots in District 13. This may be due to a compensatory catch rate of the smaller shrimp as the larger shrimp are removed, or to more abundant size-classes of small shrimp recruiting to the gear. However, this result may be due to establishment of additional set survey locations in 2000 and elimination of sets that did not produce during this time. Set survey locations are now established and should not be changed from this time forward.

Comparison of length frequency histograms for both large and small mesh pots for the entire district indicates similar but lower abundance of large shrimp and an increase in the abundance of small shrimp captured. Catch rates of all size classes of shrimp were higher in 2002 than in 2001, with more small shrimp available to survey gear. Assuming that the different set locations were sampling the same population of shrimp in Hoonah Sound, similar proportions by weight of small and large shrimp were sampled in 2002 in small and large mesh pots as compared to previous surveys, indicating that stock abundance and size distribution is similar to previous years. The proportion of large shrimp has declined slightly since 2000 but is the highest of all four surveyed districts. This appears to be a very healthy shrimp population. Postseason surveys have not been conducted to date but could indicate the extent of removal of larger shrimp within a given season.

Research Priorities

The most pressing research need for this fishery is a more detailed biometric analysis of survey data. This analysis should focus on assessing the current harvest strategy in terms of the harvest rate, and size at first harvest. Also of great importance is further soak time research in order to adjust the survey protocol to best represent shrimp population trends, as it appears that at least in District 3, pots may saturate very quickly. Underwater camera observations of shrimp pots will be employed in this work and we hope they will provide useful insights into the way pots catch shrimp. Nearshore V federal funding has been obtained to address this question.

Paired fishing of DFO shrimp traps with ADF&G shrimp traps could provide useful comparisons with our populations with their spawner index biological reference.

Of secondary but not insignificant importance is an investigation into the reason for the large differences in size composition between Districts. For each of the past 3 years of survey in District 3, the minimum and mean size at egg bearing is smaller for District 3 than for other areas surveyed. Age/size at sex change for a related Pandalid shrimp, the pink shrimp, *Pandalus borealis* has been reported to increase when growth rate slows; growth rate is a function of both intrinsic (shrimp density) (E.L. Charnov and P.J. Anderson 1989; L. Savard et al. 1994) and extrinsic (water temperature) factors, slowing at higher densities and colder water temperatures (S. Appollonio et al. 1986; L. Savard and D.G. Parsons 1990; U. Skuladottir et al. 1991). Similar factors probably drive the maturation rate of spot shrimp. Integration of the newly purchased Conductivity, Temperature and Density meters (CTD) into the pot shrimp sampling

protocols will begin to allow correlation of growth rates to bottom water temperature in the different survey areas. A tagging study would be very useful in determining spot shrimp size at age in Southeast Alaska.

Use of a third, smaller mesh pot could provide an index of the abundance of pre-recruit shrimp not currently sampled. Decreasing overall mean size in shrimp, both egg-bearing and non egg-bearing combined does indicate significantly smaller shrimp captured during recent years than in the past but could be due to a strong size class of smaller shrimp recruiting to survey pots, as in 103-25 small mesh pots fished during 2000 and 2001.

CONCLUSIONS

Stock assessment surveys are one piece of the picture to be considered in the management of Southeast Alaska Pot Shrimp Management. Commercial harvest, and dockside and onboard shrimp sampling data are also used in setting annual GHLs. However, given the proven ability of fishers to maintain catch rates while population sizes are decreasing (J.M. Orensanz et al. 1998) fishery independent surveys provide an important additional view of stock status. As only a portion of the important shrimp survey grounds are currently surveyed continuing to improve the usefulness of sampling data must also be a focus.

Preliminary analyses presented herein suggest recruitment over fishing in Districts 3 and 7 but healthy populations in Districts 12, and 13. No quantitative recommendation of the appropriate harvest level is provided, as this fishery is not yet and perhaps never will be managed by strict harvest rate management. Surveys and sampling are employed to monitor population trends and adjust harvest levels based upon population characteristics. As the survey program matures, transparent database management decision rules will be developed. A management recommendation as to 2003/04 season GHLs will be made separately to facilitate examination of all data sources.

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Table 1. Number of sets fished and number of pots sampled by statistical area, year of survey and survey type.

Preseason Surveys - pots soaked for 24 hours

Statistical Area	1996		1997		1998		1999		2000		2001		2002		2003	
	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled
103-21			11	66												
103-23			10	58	12	72	11	62	12	72	12	73	3	23		
103-25			11	70	12	71	12	71	12	74	12	77	3	24	12	80
103-30			8	47												
103-40			12	65												
Totals			*52*	*306*	*24*	*143*	*23*	*133*	*24*	*146*	*24*	*150*	*6*	*47*	*12*	*80*
107-10	5	81													12	81
107-20	9	141					18	109	17	120	12	65	15	89	15	125
107-30									3	24	3	20	3	19		
107-40	3	32					3	23	3	17	6	26	5	26		
Totals	*17*	*254*					*21*	*132*	*23*	*161*	*21*	*111*	*23*	*134*	*27*	*206*
112-41									4	28			4	25	4	24
112-42									3	15			3	12	2	12
112-45									13	85			12	77	13	80
112-48									8	57			6	26	6	38
Totals									*28*	*185*			*25*	*140*	*25*	*154*
113-55							6	45	7	35	7	31	7	39	5	25
113-57							6	38	11	46	7	29	8	57	7	43
113-58							12	72	11	56	10	45	11	69	10	62
Totals							*24*	*155*	*29*	*137*	*24*	*105*	*26*	*165*	*22*	*130*

Postseason Surveys - pots soaked for 24 hours

Statistical Area	1996		1997		1998[a)]		1999		2000		2001		2002		2003	
	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled	# sets fished	#pots sampled
103-23					12	68			12	73			3	24		
103-25					12	72			12	71	12	77	3	21		
Totals					*24*	*140*			*24*	*144*	*12*	*77*	*6*	*45*		
107-20											12	66	15	81		
107-30											3	21	3	18		
107-40											6	36	6	37		
Totals											*21*	*123*	*24*	*136*		

[a)] 1998 postseason survey conducted in February of 1999

Table 2. Estimated number captured and total number sampled for spot and coonstripe shrimp during the 1996-2003 pot shrimp surveys in Southeast Alaska.

	YEAR								
Species surveyed	1996	1997	1998	1999	2000	2001	2002	2003	Totals
District 103-Preseason									
# spot shrimp captured		32,992	23,742	25,748	27,893	26,460	41,848	26,212	204,895
# spot shrimp handled		4,273	4,477	4,613	4,007	5,532	8,542	8,925	40,369
# coonstripes captured		454	467	576	1,269	759	961	1,489	5,975
# coonstripes handled		126	185	248	167	104	75	106	1,011
District 107-Preseason									
# spot shrimp captured	8,575			1,810	3,774	1,654	3,737	10,650	30,200
# spot shrimp handled	4,727			1,508	916	564	2,606	6,788	17,109
# coonstripes captured	4,535			865	2,020	502	1,951	1,869	11,742
# coonstripes handled	1,901			485	586	333	1,434	865	5,604
District 112-Preseason									
# spot shrimp captured					14,350		21,451	30,598	66,399
# spot shrimp handled					3,866		4,983	7,986	16,835
# coonstripes captured					2,062		1,241	2,002	5,305
# coonstripes handled					228		492	116	836
District 113-Preseason									
# spot shrimp captured				12,091	11,188	8,914	13,741	17,278	63,212
# spot shrimp handled				1,918	4,335	3,618	5,222	5,142	20,235
# coonstripes captured				1,431	1,077	1,885	4,530	2,377	11,300
# coonstripes handled				95	73	164	126	82	540

Spot shrimp subtotal captured: 364,706
Spot shrimp subtotal sampled: 94,548

Coonstripe subtotal captured: 34,322
Coonstripe subtotal sampled: 7,991

	YEAR								
Species surveyed	1996	1997	1998[1)]	1999	2000	2001	2002	2003	Totals
District 103-Postseason									
# spot shrimp captured			17,597		27,611	18,365	27,791		91,364
# spot shrimp handled			3,763		4,931	4,467	8,517		21,678
# coonstripes captured			348		1,129	518	1,167		3,162
# coonstripes handled			140		148	71	104		463
District 107-Postseason									
# spot shrimp captured						2,348	1,823		4,172
# spot shrimp handled						1,654	1,523		3,177
# coonstripes captured						858	515		1,373
# coonstripes handled						858	515		1,373

Spot shrimp subtotal captured: 95,535
Spot shrimp subtotal sampled: 24,855

Coonstripe subtotal captured: 4,535
Coonstripe subtotal sampled: 1,836

[1)] 1998 Postseason survey conducted in February of 1999

Table 3. Number of non-target shrimp species captured during surveys, 1996-2003.

Common Name	Scientific name	*District 3*	*District 7*	*District 12*	*District 13*
		2003			
shrimp, unspecified	Infraorder Caridea		84		7
Pink Shrimp	*Pandalus eous*	13	104	97	139
Sidestriped shrimp	*Pandalopsis dispar*				1
Humpy shrimp	*Pandalus goniurus*				
		2002			
shrimp, unspecified	Infraorder Caridea	28	1040	2	4
Pink Shrimp	*Pandalus eous*	201	4429	394	6733
Sidestriped shrimp	*Pandalopsis dispar*		6		4
Humpy shrimp	*Pandalus goniurus*				
		2001			
shrimp, unspecified	Infraorder Caridea	8	712		20
Pink Shrimp	*Pandalus eous*	54	3788		3583
Sidestriped shrimp	*Pandalopsis dispar*		1		3
Humpy shrimp	*Pandalus goniurus*				
		2000			
shrimp, unspecified	Infraorder Caridea	64	577		4
Pink Shrimp	*Pandalus eous*	121	2512	1012	1463
Sidestriped shrimp	*Pandalopsis dispar*				
Humpy shrimp	*Pandalus goniurus*			7	
		1999			
shrimp, unspecified	Infraorder Caridea		521		
Pink Shrimp	*Pandalus eous*	21	854		3267
Sidestriped shrimp	*Pandalopsis dispar*				1
Humpy shrimp	*Pandalus goniurus*				
		1998			
shrimp, unspecified	Infraorder Caridea				
Pink Shrimp	*Pandalus eous*	32			
Sidestriped shrimp	*Pandalopsis dispar*				
Humpy shrimp	*Pandalus goniurus*				
		1997			
shrimp, unspecified	Infraorder Caridea	14			
Pink Shrimp	*Pandalus eous*	24			
Sidestriped shrimp	*Pandalopsis dispar*				
Humpy shrimp	*Pandalus goniurus*				
		1996			
shrimp, unspecified	Infraorder Caridea				
Pink Shrimp	*Pandalus eous*		3727		
Sidestriped shrimp	*Pandalopsis dispar*		14		
Humpy shrimp	*Pandalus goniurus*		5		

Table 4a. Bycatch species mean catch per pot for all years, survey types (pre-and postseason), sets and pots fished and the mean percent capture for all years, survey types, sets and pots fished for surveyed Districts 3, 7, 12, and 13 during the period 1996-2003.

Table 4b. Most prevalent bycatch species: total numbers caught per year, mean numbers caught per pot all sets combined, means for all years of mean numbers caught per pot and the mean percent capture for all years for the District 3 and 7 pot shrimp pre- and postseason surveys combined.

Table 4c. Most prevalent bycatch species: total numbers caught per year, mean numbers caught per pot all sets combined, means for all years of mean numbers caught per pot and the mean percent capture for all years for the District 12 and 13 pot shrimp pre- and postseason surveys combined.

Table 5a. Pre- and postseason pot shrimp surveys District 3, 1997-2003. By pot mean soak times, variability of mean soak times, mean catches by weight and number for spot shrimp, mean catches per hour by weight and number, variability of mean catches, mean number of pots sampled for each of two mesh sizes fished.

PRESEASON SURVEY

Small Mesh (1.125 inch stretch), Spot shrimp								
Year	Mean Soaktime (dec. hrs)	Mean Catch(Kg)	St Err of Mean Catch(Kg)	Mean Kg/hr	Mean No. caught	St Err of Mean No. caught	Mean No./hr	Total No. pots sampled (n size)
2003	25.8	5.677	2.905	0.220	239	127	9	36
2002	25.3	7.550	2.641	0.298	329	116	13	74
2001	20.9	5.582	4.048	0.263	143	175	7	70
2000	21.7	5.585	3.457	0.252	219	142	10	72
1999	21.9	6.721	3.547	0.306	240	140	11	67
1998	21.3	5.359	3.004	0.252	196	111	9	72
1997	22.3	3.737	2.318	0.172	150	88	7	21
Means:	*22.7*	*5.744*	*3.131*	*0.252*	*217*	*128*	*9*	*59*

Large Mesh (1.75 inch stretch), Spot shrimp								
Year	Mean Soaktime (dec. hrs)	Mean Catch(Kg)	St Err of Mean Catch(Kg)	Mean Kg/hr	Mean No. caught	St Err of Mean No. caught	Mean No./hr	Total No. pots sampled (n size)
2003	25.8	5.050	2.050	0.196	171	67	7	39
2002	25.3	6.686	2.417	0.263	218	79	9	76
2001	20.9	2.348	2.824	0.110	81	94	4	68
2000	21.8	4.819	3.117	0.215	157	97	7	71
1999	21.9	4.814	2.705	0.220	146	83	7	66
1998	21.3	4.366	2.945	0.205	136	90	6	71
1997	22.2	2.853	2.655	0.129	87	72	4	39
Means:	*22.7*	*4.420*	*2.673*	*0.191*	*142*	*83*	*6*	*61*

POSTSEASON SURVEY

Small Mesh (1.125 inch stretch), Spot shrimp								
Year	Mean Soaktime (dec. hrs)	Mean Catch(Kg)	St Err of Mean Catch(Kg)	Mean Kg/hr	Mean No. caught	St Err of Mean No. caught	Mean No./hr	Total No. pots sampled (n size)
2002	24.4	5.045	2.126	0.207	271	106	11	19
2001	23.0	2.734	2.863	0.119	126	128	5	60
2000	21.4	5.779	3.337	0.263	240	149	11	73
1998[a)]	20.1	3.905	2.229	0.197	151	93	8	72
Means:	*22.2*	*4.366*	*2.639*	*0.197*	*197*	*119*	*9*	*56*

Large Mesh (1.75 inch stretch), Spot shrimp								
Year	Mean Soaktime (dec. hrs)	Mean Catch(Kg)	St Err of Mean Catch(Kg)	Mean Kg/hr	Mean No. caught	St Err of Mean No. caught	Mean No./hr	Total No. pots sampled (n size)
2002	24.4	2.982	1.075	0.120	119	43	5	20
2001	22.8	2.532	2.487	0.111	87	84	4	60
2000	21.3	4.483	2.219	0.201	148	76	7	69
1998[a)]	20.1	3.434	2.113	0.168	99	59	5	68
Means:	*22.2*	*3.358*	*1.973*	*0.150*	*113*	*66*	*5*	*54*

[a)] Survey conducted in February, 1999

Table 5b. Preseason pot shrimp surveys in District 3, 1997-2003. Mean soak times, variability of mean soak times for pots fished, mean catches by weight and number for spot shrimp, mean catch per hour by weight and number, total pots sampled, and district totals for two mesh sizes fished.

Table 5c. Postseason pot shrimp surveys District 3, 1998-2003. Mean soak times, variability of mean soak times for pots fished, mean catches by weight and number for spot shrimp, mean catch per hour by weight and number, total pots sampled, and district totals for two mesh sizes fished.

Small Mesh (1.125 inch stretch), Spot shrimp									
District & Subdistrict	Mean Soaktime (dec. hrs)	St Err of Mean Soaktime	Mean Catch(Kg)	St Err of Mean Catch(Kg)	Mean No. caught	St Err of Mean No. caught	Mean Kg/hr	Mean No./hr	Total No. pots sampled (n size)
2002									
103-23	22.2717	1.0793	4.578	1.990	256	92	0.206	11.5	10
103-25	26.4722	0.7295	5.512	2.262	286	119	0.208	10.8	9
Entire District:			*5.045*		*271*		*0.207*	*11.2*	*19*
2001									
103-23									
103-25	22.9550	4.4846	2.734	2.863	126	128	0.119	5.5	60
Entire District:			*2.734*		*126*		*0.119*	*5.5*	*60*
2000									
103-23	18.9899	2.0220	3.829	2.829	183	143	0.202	9.7	37
103-25	23.8403	3.7149	7.728	3.846	297	156	0.324	12.5	36
Entire District:			*5.779*		*240*		*0.263*	*11.1*	*73*
1998[a)]									
103-23	17.8252	6.8152	4.040	2.368	181	107	0.227	10.1	35
103-25	22.4126	3.1906	3.771	2.090	122	79	0.168	5.4	37
Entire District:			*3.905*		*151*		*0.197*	*7.8*	*72*

Large Mesh (1.75 inch stretch), Spot shrimp									
District & Subdistrict	Mean Soaktime (dec. hrs)	St Err of Mean Soaktime	Mean Catch(Kg)	St Err of Mean Catch(Kg)	Mean No. caught	St Err of Mean No. caught	Mean Kg/hr	Mean No./hr	Total No. pots sampled (n size)
2002									
103-23	22.3848	1.0906	2.147	1.472	88	61	0.096	3.9	11
103-25	26.4722	0.7295	3.818	0.677	151	26	0.144	5.7	9
Entire District:			*2.982*	*1.075*	*119*	*43*	*0.120*	*4.8*	*20*
2001									
103-23									
103-25	22.7819	4.4224	2.532	2.487	87	84	0.111	3.8	60
Entire District:			*2.532*	*2.487*	*87*	*84*	*0.111*	*3.8*	*60*
2000									
103-23	18.9625	2.0771	2.234	1.772	82	65	0.118	4.3	35
103-25	23.6917	3.6498	6.731	2.667	214	87	0.284	9.0	34
Entire District:			*4.483*	*2.219*	*148*	*76*	*0.201*	*6.7*	*69*
1998[a)]									
103-23	17.6197	7.0749	2.609	1.822	87	57	0.148	4.9	33
103-25	22.5695	3.2109	4.260	2.404	111	60	0.189	4.9	35
Entire District:			*3.434*	*2.113*	*99*	*59*	*0.168*	*4.9*	*68*

[a)] Survey conducted in February, 1999

Table 6. Mean, minimum and maximum sizes for egged and un-egged shrimp captured during pre- and postseason surveys and proportion egg bearing for both large and small mesh pots for the period 1997-2003, surveyed statistical areas of District 3.

Table 7a. Pre- and postseason pot shrimp surveys district 7, 2000-2003. By pot mean soak times, variability of mean soak times, mean catches by weight and number for spot shrimp, mean catches per hour by weight and number, variability of mean catches by weight and number, mean number of pots sampled for two mesh sizes fished.

Table 7b. Pre- and postseason pot shrimp surveys District 7, 2000-2003. By pot mean soak times, variability of mean soak times, mean catches by weight and number for coonstripe shrimp, mean catches per hour by weight and number, variability of mean catches by weight and number, mean number of pots sampled for two mesh sizes fished.

Table 7c. Preseason pot shrimp surveys District 7, 1996-2003. Mean soak times, variability of mean soak times for pots fished, mean catches by weight and number for spot shrimp, mean catch per hour by weight and number, total pots sampled, and district totals for two mesh sizes fished.

Table 7d. Postseason pot shrimp surveys District 7, 2001-2002. Mean soak times, variability of mean soak times for pots fished, mean catches by weight and number for spot shrimp, mean catch per hour by weight and number, total pots sampled, and district totals for two mesh sizes fished.

Table 8a. Mean, minimum and maximum sizes for egged and un-egged spot shrimp captured during preseason surveys and proportion egg bearing for both large and small mesh pots for the period 1996-2003, surveyed statistical areas of District 7.

Table 8b. Mean, minimum and maximum sizes for egged and un-egged spot shrimp captured during postseason surveys and proportion egg bearing for both large and small mesh pots for the 2001-2003 surveyed statistical areas of District 7.

Table 9a. Pre- and Postseason pot shrimp surveys District 12 and 13, 1999-2003. By pot mean soak times, variability of mean soak times, mean catches by weight and number for spot shrimp, mean catches per hour by weight and number, variability of mean catches by weight and number, mean number of pots sampled for two mesh sizes fished.

Table 9b. Preseason pot shrimp surveys District 12, 2000-2003. Mean soak times, variability of mean soak times for pots fished, mean catches by weight and number for spot shrimp, mean catch per hour by weight and number, total pots sampled, and district totals for two mesh sizes fished.

Table 9c. Preseason pot shrimp surveys District 13, 1999-2003. Mean soak times, variability of mean soak times for pots fished, mean catches by weight and number for spot shrimp, mean catch per hour by weight and number, total pots sampled, and district totals for two mesh sizes fished.

Table 10a. Mean, minimum and maximum sizes for egged and un-egged shrimp captured during pre- and postseason surveys and proportion egg bearing for both large and small mesh pots for the 2000-2003 surveys of District 12, all statistical areas.

Table 10b. Mean, minimum and maximum sizes for egged and un-egged shrimp captured during pre- and postseason surveys and proportion egg bearing for both large and small mesh pots for the surveyed years 1999- 2003 in District 13, all statistical areas.

Figure 1. Locations of statistical areas of Districts 3 (Cordova Bay), 7 (Ernest Sound), 12 (Tenakee Inlet) and 13 (Hoonah Sound) in which standardized pot shrimp surveys have been conducted in Southeast Alaska.

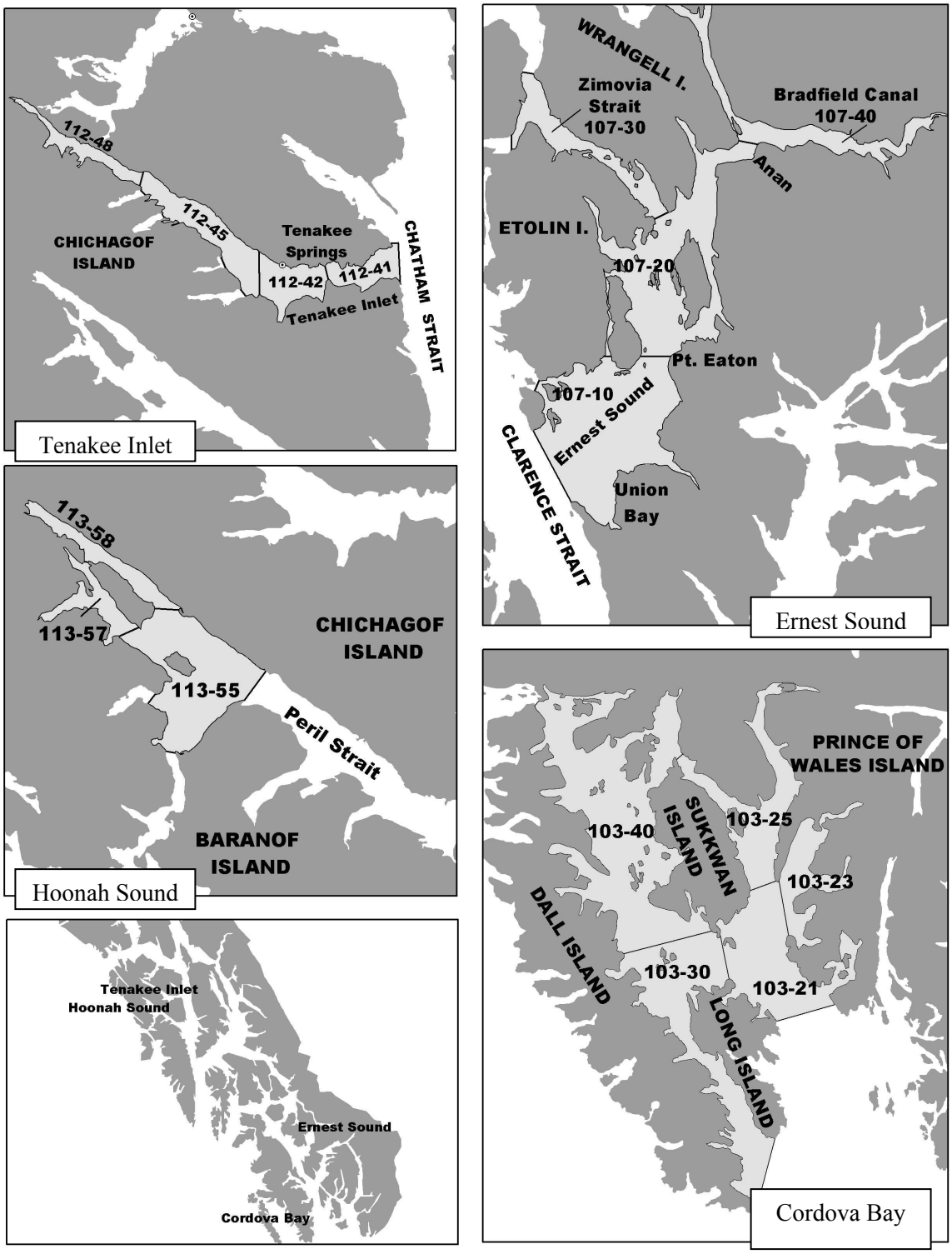


Figure 2. District 3, mean catch in kg per pot and number per pot and standard errors for these measures for spot shrimp sampled with small and large mesh pots from statistical areas 103-23 and 103-25, 1997-2003 pre- and postseason surveys. Solid lines are preseason surveys, dashed lines are postseason surveys.

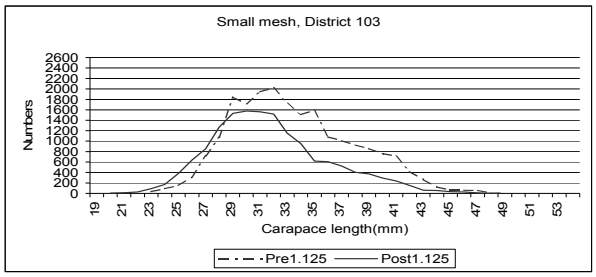
Catches in Numbers of Shrimp

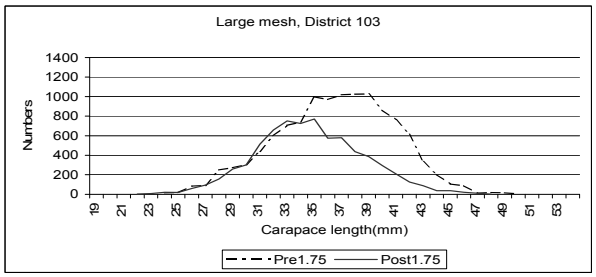
Catches by weight of Shrimp

Figure 3. District 3, 7, 12 and 13. preseason surveys, 1998-2002. Length frequency graphs depicting catches of spot shrimp, by mesh size fished during surveys.

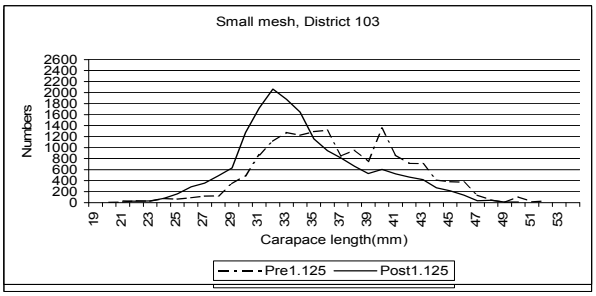
Figure 3a. District 3, pre- and postseason surveys, 1998-2002. Length frequency graphs depicting catches of spot shrimp, by mesh size for statistical areas 103-23 and 103-25 combined. No postseason survey conducted in 103-23 during 2001.

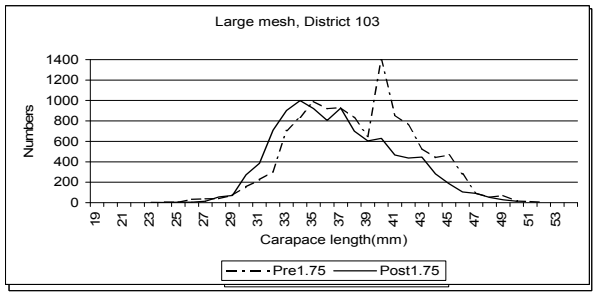
2002



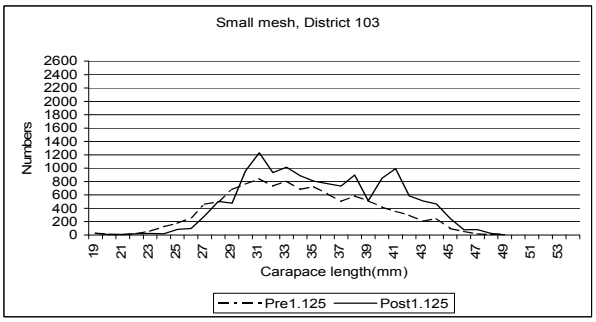


2000
2001





1998



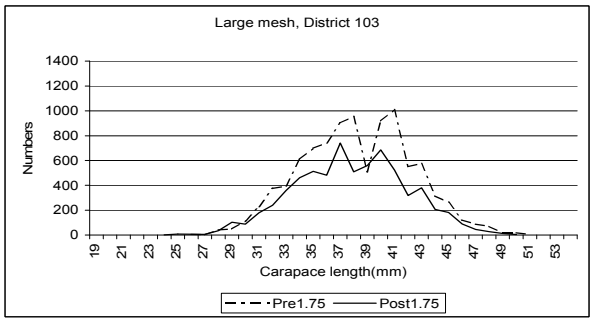
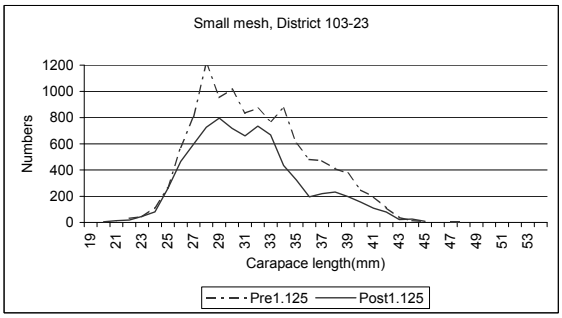
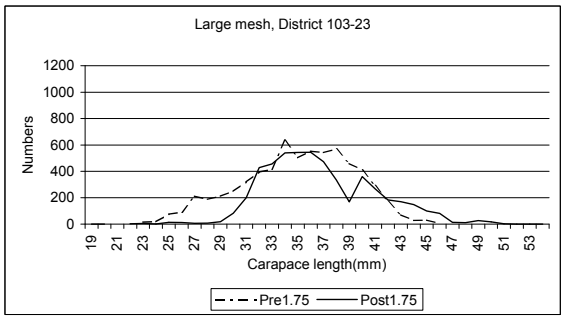


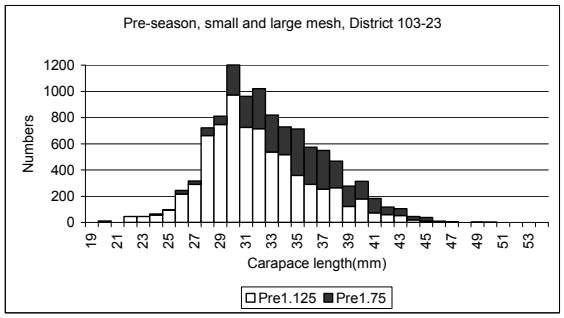
Figure 4b. District 3, statistical area 103-23, pre- and postseason surveys, 1998-2002. Length frequency graphs depicting catches of spot shrimp, by mesh size and comparing catches pre- and post- commercial fishery.

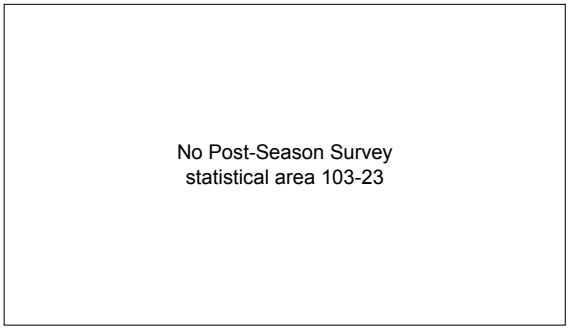
2002



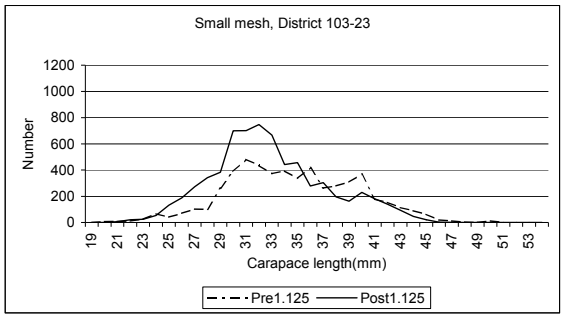


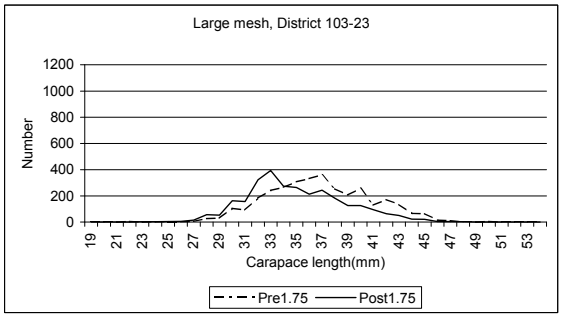
2001



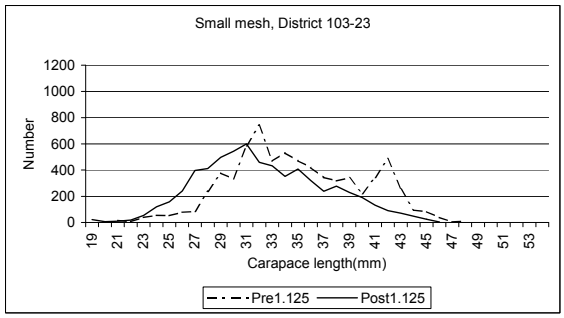


2000





1998



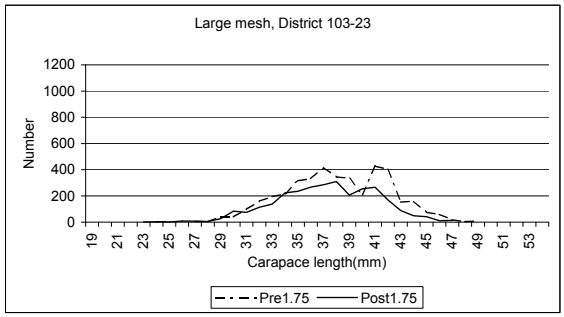
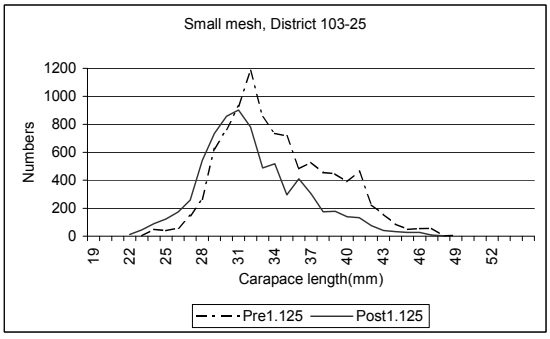
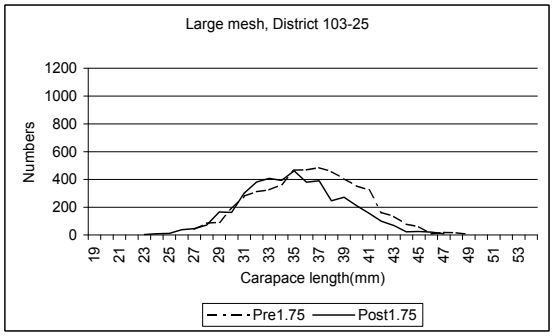


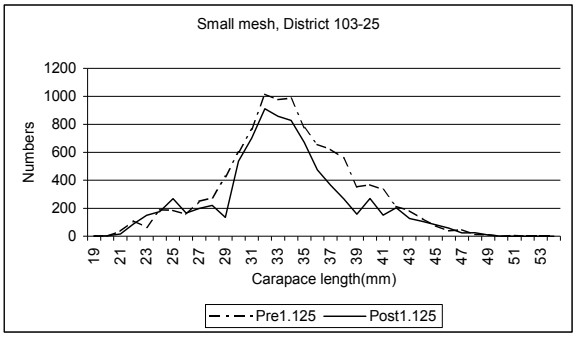
Figure 4c. District 3, statistical area 103-25, pre- and postseason surveys, 1998-2002. Length frequency graphs depicting catches of spot shrimp, by mesh size and comparing catches pre and post commercial fishery.

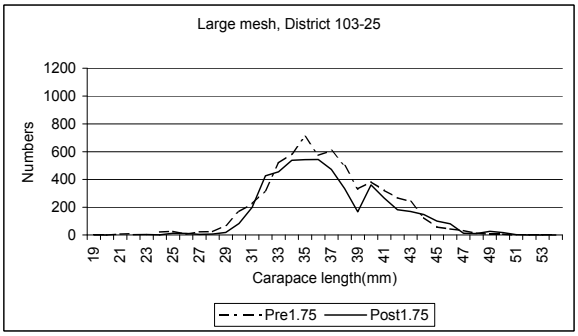
2002





2001





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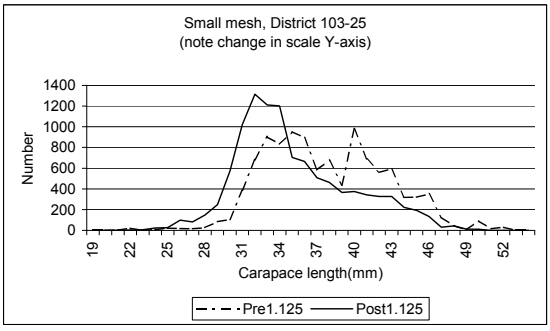
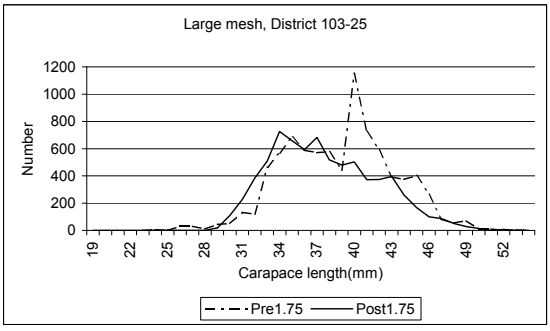
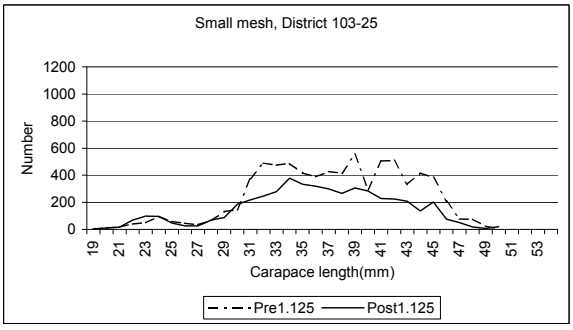




1998



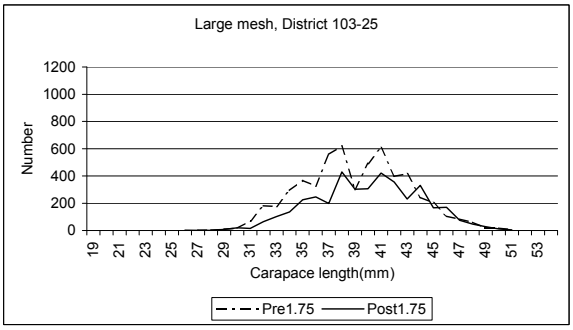


Figure 5. District 3, mean carapace length (mm) and standard deviation of mean carapace length for spot shrimp captured in small and large mesh pots for District 3 and statistical areas 103-23 and 103-25, 1997-2001 preseason surveys.

Figure 6a. Catches in Kg of spot shrimp by size category for small and large mesh pots fished during preseason surveys in District 3, statistical areas 103-23 and 103-25 during 1997-2003.

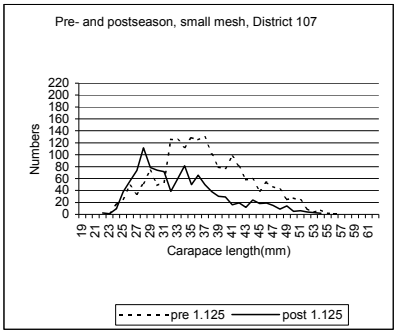
Figure 6b. Proportion of the catches of spot shrimp based on weight (in kg) by size category captured in large and small mesh pots fished during surveys in statistical areas 103-23 and 103-25, District 3, 1997-2003 preseason surveys.

Figure 6c. Proportion of the catches of spot shrimp based on weight (in kg) by size category captured in large and small mesh pots fished during surveys in statistical areas 103-23 and 103-25, District 3, 1997-2003 postseason surveys.

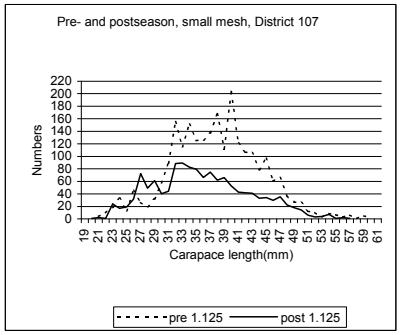
Figure 7. District 7, statistical areas 107-10, 20, 30 and 40, mean catch in kg per pot and numbers per pot and the standard deviations for these measures, 1996-2003 pre- and postseason surveys for small and large mesh pots. Solid lines preseason surveys, dashed lines for postseason surveys.

Figure 8a. District 7, pre- and postseason surveys, 2001-2002 length frequency graphs depicting catches of spot shrimp, by mesh size fished. Preseason surveys, 1999-2000 stacked-bar length frequency graphs depicting catches of spot shrimp by mesh size fished.

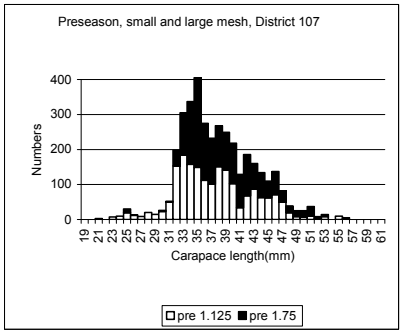
2002

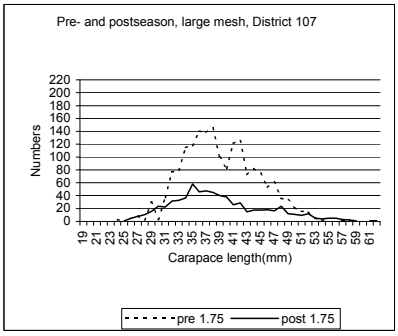


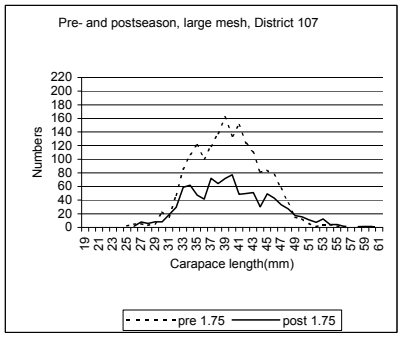
2001



2000



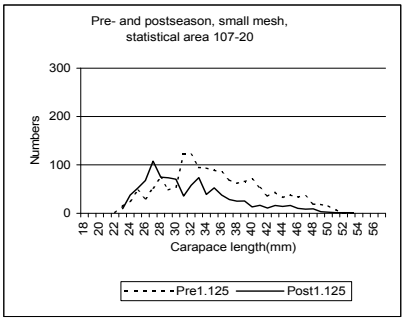


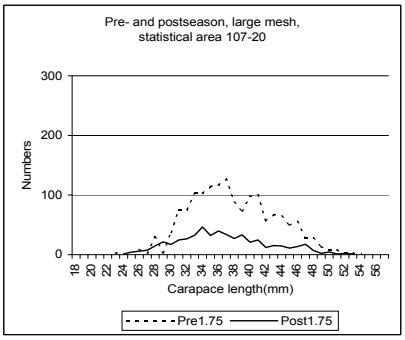


No post-season survey
District 107 in 2000

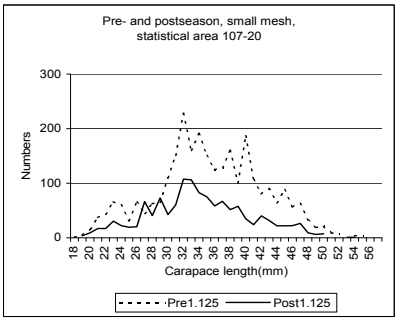
Figure 8b. District 7, statistical area 107-20. Pre- and postseason surveys, 2001-2002 length frequency graphs depicting catches of spot shrimp, by mesh size fished. Preseason surveys, 1999-2000 stacked-bar length frequency graphs depicting catches of spot shrimp by mesh size fished.

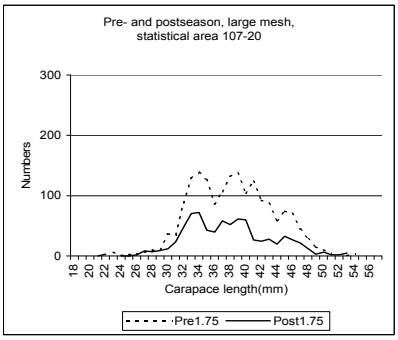
2002



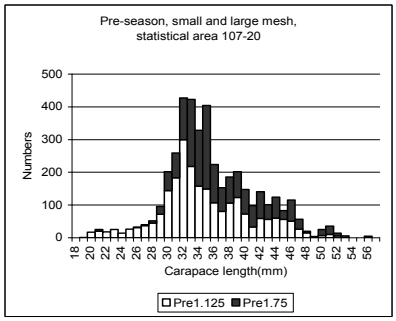


2001



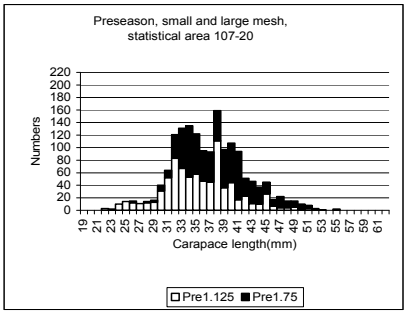


2000



No post-season survey,
statistical area 107-20
in 2000

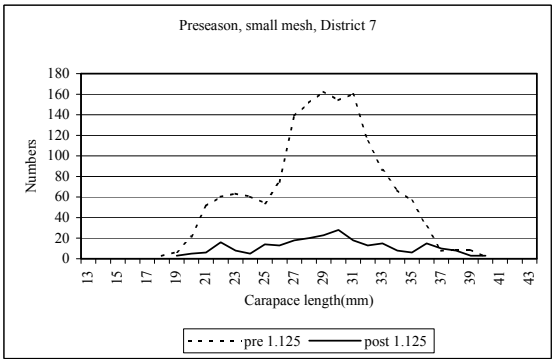
1999

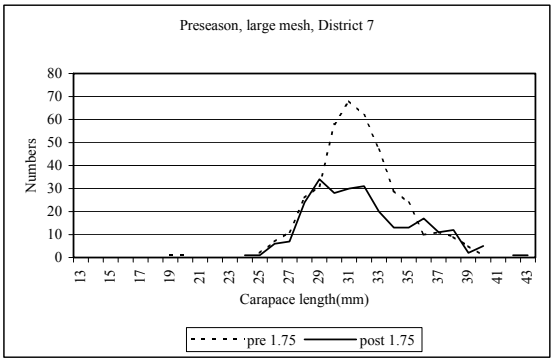


No post-season survey,
statistical area 107-20
in 1999

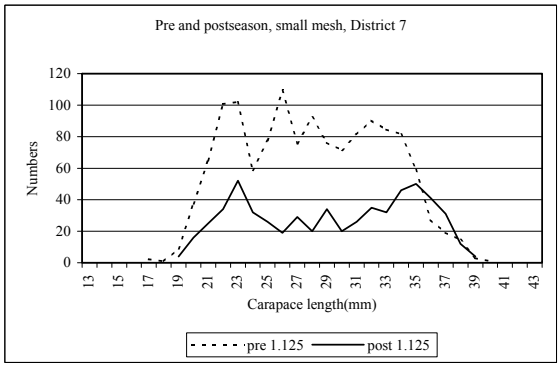
Figure 9a. Statistical area 107-20, pre and postseason surveys, 2001-2002. Length frequency graphs depicting catches of coonstripe shrimp, by mesh size fished.

2002





2001



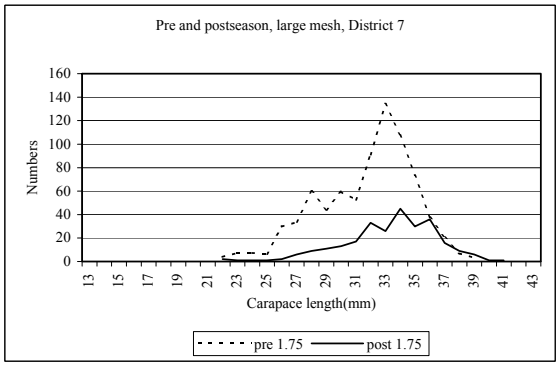


Figure 9b. District 7, preseason surveys, 2000-2002. Length frequency graphs depicting catches of coonstripe shrimp, by mesh size fished.

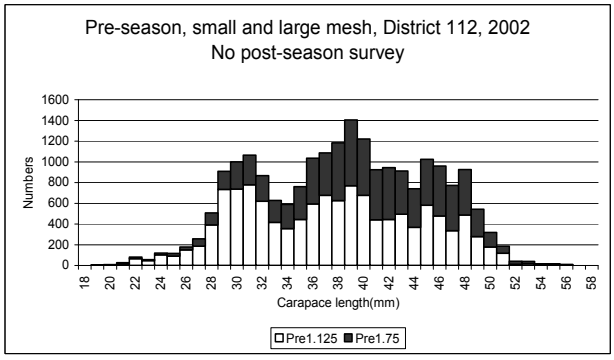
Figure 10. District 7, statistical areas 107-20, 30, and 40, mean carapace lengths (mm) and standard deviation of mean carapace length for spot and coonstripe shrimp captured with small and large mesh pots, for 1999-2002 pre- and postseason surveys. Solid lines preseason, dashed lines postseason surveys.

Figure 10a. Catches in Kg of spot shrimp by size category for small and large mesh pots fished during pre- and postseason surveys in District 7, and by statistical area 107-20, during 1996-2003.

Figure 10b. Proportion of catches of spot shrimp based on weight (in kg) by size category, large and small mesh pots, preseason surveys, Districts 7, and by statistical area 107-20.

Figure 12. District 12, mean catch in kg per pot and number per pot and standard errors for these measures for spot shrimp sampled with small and large mesh pots from all statistical areas combined and from 112-45 during 2000-2003 preseason surveys. Solid lines are preseason surveys, dashed lines are postseason surveys.

Figure 13. District 12, preseason surveys, 2000 and 2002. Stacked column length frequency graphs depicting catches of spot shrimp, by mesh size fished.



No pre- or post-season surveys,
District 112 in 2001

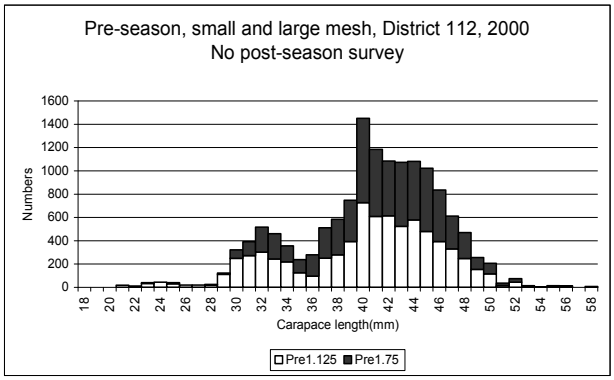


Figure 14. District 12, and statistical area 112-45, mean carapace lengths (mm) and standard deviation of mean carapace length for spot and coonstripe shrimp captured with small and large mesh pots, for 2000-2003 preseason surveys. Solid lines preseason, dashed lines postseason surveys.

Figure 15a. Catches in Kg of spot shrimp by size category for small and large mesh pots fished during pre- and postseason surveys in District 12, and by statistical area 112-45, during 2000-2003.

Figure 15b. Proportion of catches of spot shrimp based on weight (in kg) by size category, large and small mesh pots, preseason District 12 and statistical area 112-45, 2000-2003.

Figure 16. District 13, mean catch in kg per pot and number per pot and standard errors for these measures for spot shrimp sampled with small and large mesh pots from all statistical areas combined and from 113-58 during 1999-2003 preseason surveys. Solid lines are preseason surveys, dashed lines are postseason surveys.

Figure 17. District 13, preseason surveys, 1999 and 2002. Stacked column length frequency graphs depicting catches of spot shrimp, by mesh size fished.

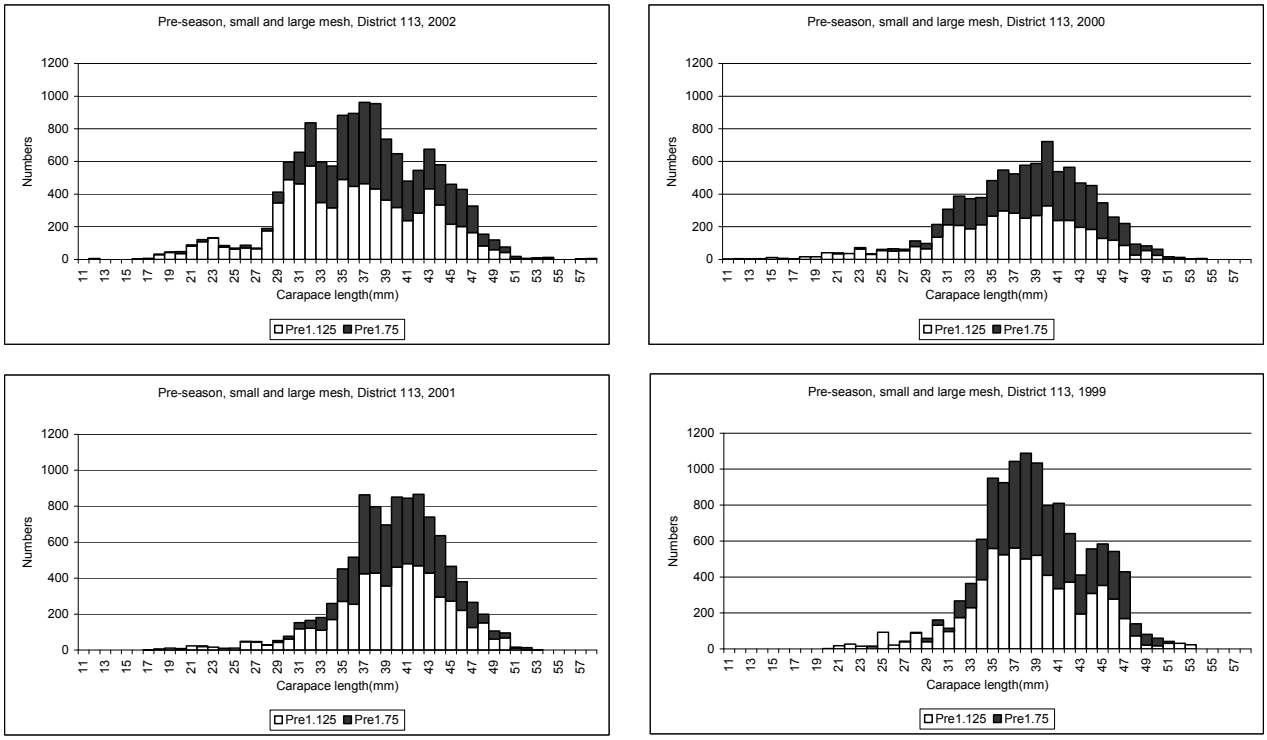


Figure 18. District 13, mean carapace length (mm) and its standard deviation for spot and coonstripe shrimp captured during 1999-2002 preseason surveys.

Figure 19a. Catches in Kg of spot shrimp by size category for small and large mesh pots fished during pre- and postseason surveys in District 13, and by statistical area 1123-58, during 1999-2003.

Figure 19b. Proportion of catches of spot shrimp based on weight (in kg) by size category, large and small mesh pots, preseason District 13 and statistical area 113-58, 1999-2003.

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